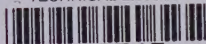


ROTEK INSTRUMENT CORP.

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19767

MODEL 710

AC/DC WIDE BAND
METER CALIBRATOR

OPERATING & SERVICE MANUAL

3rd Printing

A D V A N C E D

CALIBRATION EQUIPMENT



MODEL 710
AC/DC WIDE BAND
METER CALIBRATOR
OPERATING & SERVICE MANUAL

3rd Printing

Effective starting Serial Number 165

CERTIFICATION

Rotek Instrument Corp. certifies that this instrument has been calibrated to meet or exceed all the specifications contained in this manual prior to being shipped from the factory. The calibration has been performed with instruments the accuracies of which are traceable to the National Bureau of Standards.

WARRANTY

Rotek Instrument Corp. warrants each instrument manufactured by it to be free from defects in material and workmanship for a period of one year from the date of delivery to the original purchaser, provided the instrument is used in accordance with the instructions in this manual. Rotek's obligation under this warranty is limited to servicing or adjusting an instrument returned to the factory, transportation charges prepaid, for that purpose. This is the only warrant offered in connection with the sale of this instrument, no other warranty is implied. Rotek is not liable for consequential damages.

If a fault in operation occurs, the following steps should be taken:

1. Notify Rotek Instrument Corp. giving full details of the faulty operation, the model number and serial number of the instrument. On receipt of this information, service data or shipping instructions will be provided.
2. On receipt of the shipping instructions, forward the instrument prepaid and repairs will be made at the factory.

If it is necessary to return this instrument to the factory, it should be shipped in the original packing carton. If it is not available, use any suitable rigid container with adequate packing to protect the unit during transit.

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SECTION 1

GENERAL INFORMATION

1.1 Description

The Model 710 Wide Band Precision Calibrator is a precision source of direct and low distortion alternation voltage and current, providing voltages from 0.001 to 1000 volts and currents from 0.001 milliamperes to 1000 milliamperes, from dc to 100,000 Hertz. The Model 710 has a deviation control which provides a readout of meter error on a decimal display. The Model 710 also provides a selection of eight standard resistance values for determining the accuracy of resistance functions in multimeters.

The voltage and current settings may be controlled from the front panel via switches or remotely by logic levels applied through interface modules described in Section 1.3 below. The transfer from remote control to manual control is accomplished by pressing a front panel switch, and the transfer back to remote is accomplished by pressing the Remote front panel button. Thus an operator can, at his option, function in the remote or manual mode. The output is provided at a set of terminals which, for voltage values from 0.1 volt to 1000 volts or resistance, may be arranged in the four wire configuration. The Calibrator features an internal guard to protect the sensitive parts of the circuit from being capacitively coupled to the case.

Because of the high accuracy and the rapid settling time (even at 50Hz) the Model 710 finds application in the calibration of analog volt meters ammeters, multimeters and three, four and five digit ac and dc digital multimeters.

1.2 Accessories

Model 750 High Current Adapter

In the current mode, the range of the Model 710 may be extended to 10 Amperes dc and 50 Amperes ac from 50 to 400Hz in the Model 750 High Current Adapter. The output of the High Current Adapter is controlled by the Model 710 in either the manual or remote modes. Electrical specifications for the Model 750 are included under the ac and dc current headings in Section 1.4.

1.3 Options

1.3.1 IEEE Standard 488-1975 Interface

This interface provides remote control by byte serial ASCII Characters in accordance with the standard in the Listener, Talker and Service Request functions. Specifications for this interface are given in Section 1.4.

1.3.2 Readout of Deviation with Printer Interface

The deviation is available electrically as three BCD digits and a binary digit representing each of three multipliers. A switch activated print command signal is transmitted and hold printer input is provided.

1.4 Specifications

All accuracy specifications obtain within two hours after turn on at a temperature of 25 ± 2 C, relative humidity of 50% maximum, a line frequency of 50 to 60Hz, at nominal line voltage $\pm 5 - 10\%$, from 10 to 100 percent on any range, including loading or compliance except as otherwise specified and are maintained for a period of not less than six months.

Nominal line voltages are selectable (at installation) as 100, 120, 220 and 240 volts RMS. All specifications describe maximum limits unless stated otherwise.

1.4.1 Functions and Ranges

Voltage AC & DC:

1000V, 100V, 10V, 1000mV, 100mV, 10mV
1mV to 1000V AC (to 20kHz)
1mV to 100V AC (to 100kHz)
1uV to 1000V DC.

Four wire connections 0.1 volt to 1000 volts
Sense input impedance 1000 ohms per volt

Current AC & DC:

1000mA, 100mA, 10mA, 1000uA, 100uA, 10uA Ranges
10 Amp AC & DC, 50 Amp AC only (with Model 750)
10uA to 50 Amps AC (with Model 750)
1nA to 10 Amps DC (with Model 750)

Frequency:

10 to 1000000Hz
Hz, Hzx10, Hzx100, Hzx1000 Ranges
Two decade dials
Accuracy $\pm 5\%$

Amplitude Settability - Resolution

Voltage/Current:

Six decade dials
Resolution 0.0001%

Ohms:

Cardinal Values, 1, 10, 100, 1K, 10K, 100K, 1 Meg, 10 Meg
Kelvin 4 wire connections

Deviation:

0.1, 1.0, 10% Ranges
3 digit plus decimal point display
(not active in the ohms mode)

1.4.2 DC Voltage

Accuracy:

1 - 500V: $\pm(0.002\% \text{ setting } +0.0002\% \text{ range})$
1 - 1000V: $\pm(0.003\% \text{ setting } +0.0002\% \text{ range})$
1uV - 1000mV: $\pm(0.002\% \text{ setting } +0.0002\% \text{ range } +2\mu\text{V})$

Low Frequency Fluctuations (f < 1Hz)
10 ppm RMS setting

Line Frequency and Other Noise (f > 1000Hz)
100mV - 1000V: 0.05% setting +50uV RMS
1uV - 100uV: 0.05% setting +10uV RMS

Loading:

1000V range: 10mA to 700V; decreases linearly to 5mA
at 1000V
100V range: 10mA
10V range: 100mA
1000mV range: 35mA,
10, 100mV ranges: 10 ohm output impedance approximately

Temperature Coefficient: (15-23C; 27-35C)
 $\pm(3 \text{ ppm setting } +0.3 \text{ range } +1\mu\text{V})/\text{C}$

Line Voltage Sensitivity:
 $\pm 1 \text{ ppm/percent line voltage change}$

1.4.3 DC Current

Accuracy:

10nA - 100nA: $\pm(0.01\% \text{ setting } +0.002\% \text{ range } +50\text{nA})$
100nA - 1000mA: $\pm(0.01\% \text{ setting } +0.005\% \text{ range})$
1 - 10 Amps: $\pm(0.05\% \text{ setting } 500\mu\text{A})$ (with Model 750)

Compliance:

10nA - 1000mA: 2V DC
1 - 10 Amps: 2V DC (with 750)

Low Frequency Fluctuations (f < 1Hz)
5 ppm setting +25nA

Line Frequency and Other Noise:
0.01% setting +0.02% range +50nA

Temperature Coefficient: (15-23C; 27-35C)
 $\pm(20 \text{ ppm setting } +5 \text{ ppm range } +25\text{nA}/\text{C})$

Line Voltage Sensitivity:
2 ppm/percent line voltage change

1.4.4 AC Voltage

Voltage Accuracy

10mV - 1000V

Including effects of distortion and noise as measured with average or RMS responding meter.

Frequency Specification Limit

* 10 - 39Hz	+(0.1% setting +0.01% range +10uV) (10V maximum)
40 - 49Hz	+(0.06% setting +0.006% range +10uV)
400 - 1000Hz	+(0.025% setting +0.0025% range +10uV)
50 - 10000Hz	+(0.05% setting +0.005% range +10uV) (.01 to 1000V)
11 - 20000Hz	+(0.05% setting +0.005% range +10uV) (.01 to 100V)
11 - 20kHz	+(0.08% setting +0.008 range +10uV) (100 to 1000V)
21 - 50kHz	+(0.08% setting +0.008% range +10uV) (.1 to 100V)
51 - 100kHz	+(0.1% setting +0.01% range +20uV) (.1 to 100V)

Loading:

1000V Range	20mA Resistive & 150pf to 10kHz, 10mA Resistive or 50pf to 20kHz
100V Range	200mA Resistive & 200pf
10V Range	50mA & 500pf
1000mV Range	35mA & 500pf
100-10mV Range	10 Ohm output impedance

Distortion and Noise

* 10 - 39Hz	0.2% setting +0.04% range +100uV		
40 - 49Hz	0.05% setting +0.015% range +100uV	50uV	below 100mV
50 - 100Hz	0.05% setting +0.01% range +100uV	"	" "
101 - 5000Hz	0.05% setting +100uV	"	" "
5.1 - 10kHz	0.1% setting +200uV	"	" "
10.1 - 50kHz	0.2% setting +200uV	"	" "
50 - 100kHz	0.5% setting +200uV		
Add 100uV with 710-IEEE Option			

Temperature Coefficient (15-23C; 27-35C)

50Hz - 10kHz:	+(15 ppm setting +1 ppm range per C)
10-50Hz; 10-20kHz:	+(50 ppm setting +1 ppm range per C)
20kHz - 100kHz:	+(300 ppm setting +10 ppm range per C)

Line Voltage Sensitivity

5 ppm/percent line voltage change

* Specifications derated linearly from 40Hz to 10Hz.

1.4.5 AC Current

Accuracy

Including effects of distortion and noise as measured on average or RMS responding meter. Resistive or capacitive loads (Accuracy in % as related to Setting and Range)

Range	100uA				1000uA - 1000mA			
Compliance	0.25V Maximum				1.0V Maximum		2.0V Maximum	
Frequency	Setting Range		Setting Range		Setting Range		Setting Range	
40 - 49Hz	0.06	0.006	0.06	0.006	0.06	0.006	0.06	0.02
50 - 200Hz	0.05	0.005	0.05	0.005	0.05	0.005	0.0	0.015
210 - 400Hz	0.02	0.005	0.05	0.005	0.05	0.005	0.05	0.01
410 - 1kHz	0.05	0.01	0.05	0.005	0.05	0.005	0.05	0.035
1 - 5kHz	-	-	0.25	0.005	-	-	-	-
5 - 10kHz	-	-	0.5	-	-	-	-	-
11 - 20kHz	-	-	1.5	-	-	-	-	-

Accuracy varies logarithmically with frequency between specified frequencies.

Accuracy Model 750A - Accessory equipment

Range	1 - 10A			10 - 50A
Compliance	.5V	1V	2V	.25V
Frequency				
50 - 100	0.05% +500uA	0.05% +500uA	0.05% +500uA	0.2% +5mA
110 - 400	0.05% +500uA	0.05% +500uA	0.05% +500uA	0.2% +2mA
410 - 1KHz	0.05% +500uA	0.05% +500uA	0.05% +500uA	-
1 - 10KHz	0.25% +5mA			

Distortion and Noise (See AC Voltage)

Temperature Coefficient (15-23C, 27-35C)

+ (30 ppm setting + 5 ppm of range/C)

40Hz - 10KHz

+ (100 ppm setting/C) greater than 10KHz

Additional Errors for Inductive Loads (300uHys maximum.)

$$\begin{aligned} 10\mu\text{A} - 10\text{mA}: & \quad 0.01\% \\ 10\text{mA} - 100\text{mA}: & \quad \frac{2\pi f^2 L}{500000}\% \end{aligned}$$

$$100\text{mA} - 1\text{A}: \quad \frac{2\pi F^2 L}{500000}\%$$

1.4.6 Ohms (At relative Humidity of 50%)

1.4.6.1 Resistance (4 wire connection)

1 - 10 ohms	0.01%
100 ohms - 1 meg ohm	0.005%
10 meg ohms	0.05%

1.4.6.2 Resistance (2 wire connection)

1 - 1000 ohms	0.350 ohms
10k - 1 meg	0.005%
10 meg	0.05%

Temperature Coefficient of Resistance

1 ohms, 20 ppm/C; 10 ohms, 15 ppm/C; 100 ohms, 10 ppm/C
1K - 1 meg, 3 ppm/C; 10 meg, 50 ppm/C

+10 microvolts maximum in series with resistors less than 1K ohm in value.

Maximum Dissipation:

1 ohm	0.01 watts
10 - 10 meg	0.025 watts or voltage not to exceed 10 volts, whichever is the lesser.

1.4.7 Deviation

Range: OFF, 0.12%, 1.20%, 12% Full scale.
Accuracy: 1.2% reading ± 1 digit.

1.4.8 Remote Operation via IEEE 488 Interface (Option)

The Series 600 performs in accordance with the following subsets of the Interface Standard.

Source Handshake	SH1
Acceptor Handshake	AH1
Listener	L4
Talker	T6
Service Request	SR1

Listener Function:

Receives function, range, amplitude and frequency settings and status (operate/standby) data.

Service Request:

Requests service after asserting status instructions and after measurement of meter error.

Talker:

Sends meter error data.

1.4.9 General

Weight: 26Kg. (57 lbs.)

Dimensions: 222 mm. (8.175 in.) High X 437 mm. (17.25)
Wide X 495 mm. (19.5 in.) Deep behind Rack
Mtg. surface.

Power: 150 Watts at nominal line voltage in Standby
100/120/220/240 volts, +5, -10%, 50/60Hz

Ambient Operating Temperature: 15 - 35C

Relative Humidity: 50% Maximum

SECTION 2

OPERATING INSTRUCTIONS

2.1 Power Requirements

The Model 710 can be operated from an ac power source of 100, 120, 220 or 240 volts (+5, -10%), 50/60Hz. The selection of line voltage operation is made prior to connecting the instrument to the power source by inserting the PC adapter board in the ac receptacle (located on the rear panel) with the appropriate line voltage mark readable. This line fuse is rated at 4 Amps Slow Blow for 100, 120 volts; 2.5 Amps Slow Blow for 220, 240 volts.

A three conductor power cable is provided; when this conductor is connected to a standard three wire outlet the instrument chassis is connected to the power system ground. This prevents the instrument case from assuming voltages hazardous to personnel. In the event an adapter (cheater) is used to connect the three wire conductor to a two wire power source the green adapter terminal should be connected to the power system ground. An overtemperature switch is connected in series with the ac power line internal to the instrument.

2.2 Installation

The Model 710 standard configuration is bench mounting. Combination handles and rack mounting ears are available on special order and are interchangeable with the standard bench mounting handles.

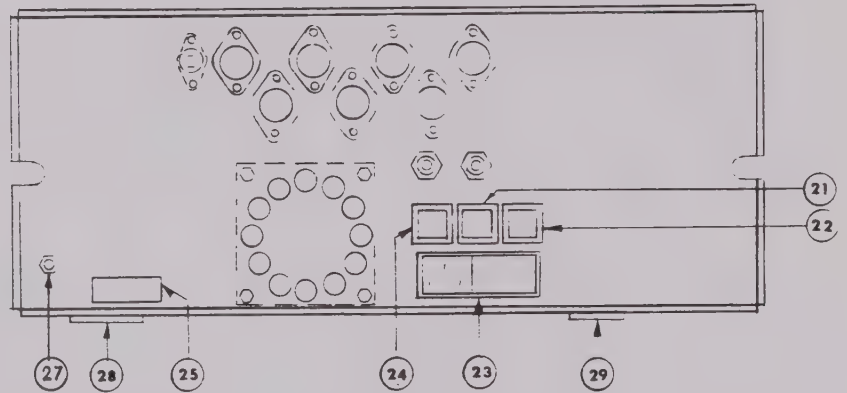
2.3 Controls and Displays

Figure 2-1 illustrates and describes the function of all front and rear panel controls, connections and indicators. Each element of control, display or connection is numbered and the description of the function appears under the number in the table of the figure.

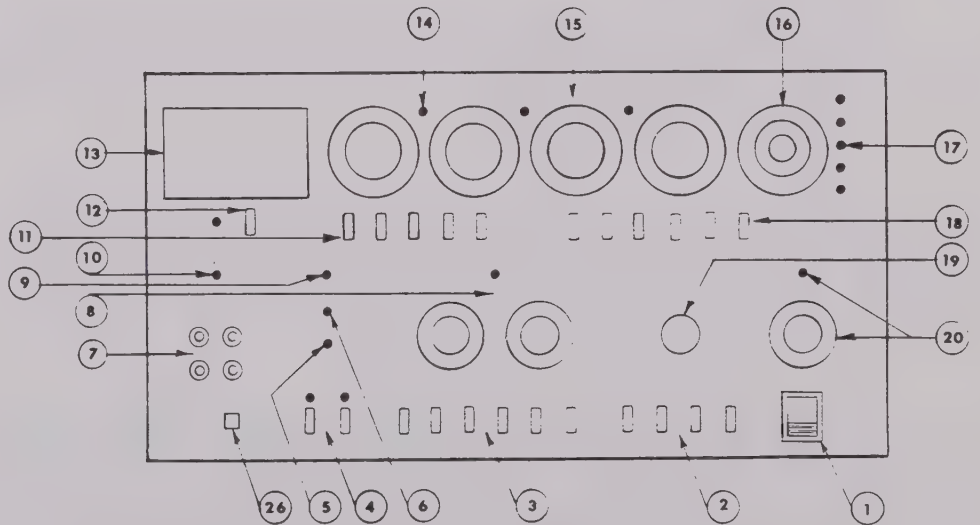
2.4 General Operating Information

The Model 710 has three modes of operation, voltage, current and resistance. In the current mode of operation the Model 750A High Current Adapter may also be employed, its output being controlled by the setting of the 710. This operation is described separately in the manual for the Model 750A. In the voltage mode, voltage setting may be varied from 1.000 millivolt (0.000 in dc) to XXX.X volts (corresponding to 1111.0 volts). Positive or negative direct voltages or alternating voltages at frequencies of 10 through 100000Hz may be selected.

In the current mode, current settings from 1.000 microampere (0.000 in dc) to XXX.X milliamperes (corresponding to 1111.0 milliamperes) may be obtained as positive or negative direct currents or alternating currents at 40 through 20000 Hertz.



-REAR PANEL-
(AIR BLOWER ASSY. REMOVED)



-FRONT PANEL-

DATE 2-14-84		APPROVED	DRAWN BY M.W.
ROTEK INSTRUMENT		CORP.	
FRONT & REAR PANEL		PROJECT NO. 07-100-110	

- 1 Power (Includes ON indication)
Switch (Toggle) to energize the Calibrator.
- 2 Deviation Range Selector
Four interlocked push switches which select the deviation range, 0.1%, 1.0% and 10% and off. Corresponding full scale deviations are approximately 0.12%, 1.2% and 12%. The off position disables the deviation control.
- 3 Frequency Function Controls
Six interlocked push switches selecting +dc, -dc, Hz, Hz x 10, Hz x 100 or Hz x 1000.
- 4 Output Controls
Two independent momentary push switches, with a red LED for Operate and a green LED for Standby. Pushing Standby causes the output to be disconnected from the active circuits and shorts the output High terminal to the output Low terminal. Pushing Operate causes the output to assume the selected function and setting.
- 5 Setting Error Indicator
This indicator is illuminated when a setting of amplitude or frequency or a combination thereof is not functional. The Calibrator is maintained in the Standby state when this indicator is illuminated.
6. Use 750A Indicator
This indicator is illuminated when the requested current is greater than 1 Amp and the Model 750A output is to be used.
7. Output Terminal Array
Sense terminal High and Low are connection points for the meter under calibration. Output High and Low terminals may be used for four wire connections and loading, otherwise they are shorted internally by low thermal connections to their respective sense terminals. The two/four wire selection switch controls the arrangement of the terminals.
8. Frequency Setting Controls
Two rotary selector switches which select the frequency in Hz, which is multiplied by the frequency range multiplier. The ac indicator is illuminated whenever a frequency range is selected. The most significant decade dial may be set from 1 to X.
9. 10 Ohms Output Z
This is a warning indicator that the output resistance at the Output terminals is now 10 Ohms. Caution should be used when calibrating analog instruments under these conditions.

- 10 **High Voltage Indicator**
LED Indicator which is illuminated whenever the output voltage is high enough that there is a hazard from shock.
- 11 **Function Controls**
Five interlocked push switches selecting the operating function as volts, amps, 10 amps (option), ohms or remote (option). The option switches are not functional unless the option is ordered.
- 12 **Record Deviation Control**
This switch is momentarily pressed to output a record or print command signal. The associated Hold indicator is used with the 710-IEEE option and any printer which has a busy signal to indicate that data transfer is occurring.
- 13 **Digital Deviation Readout**
Displays the deviation in % of setting as a 2-1/2 digit readout. The maximum reading on the highest range is approximately 12%; the resolution on the lowest range is .001% setting. The display is blanked when the deviation OFF button is selected.
- 14 **Decimal Point Indicators**
Shows location of applicable decimal point in one of three positions.
- 15 **Output Setting Controls**
Six decade selector switches which determine the output voltage and current amplitude. The most significant decade is usable from 1 to 10 except 0 to 10 in dc current and voltage ranges ≤ 10 . The remaining decades may be set from 0 to 10.
- 16 **Sixth Decade is a concentric with fifth decade.**
- 17 **Function Indicators**
Five indicators, one of which displays the units modifier for the voltage and/or current setting.
- 18 **Range Controls**
Six interlocked push switches selecting the ranges 1000, 100, 10 volts or milliamperes, 1000, 100, 10 millivolts or microamperes.
- 19 **Deviation Control**
A potentiometer which inserts change in the output to measure the meter under test error. This change is displayed by the Deviation indicator in % of setting.
- 20 **Ohms Selector (Ohms ON indicator)**
An eight position rotary switch connecting one of the resistors to the output terminals in the Ohms mode. Available resistors are 1 Ohm through 10 Meg Ohms in decade values.

(Continued on next page)

- 21 Fuse +33Vdc, 5A Slow Blow
 - 22 Fuse +5Vdc, 3A Slow Blow
 - 23 Combination Line Cord Receptacle, Fuse, Line Voltage Selector
To replace fuse, remove line cord and pull "Fuse" lever.
Replace with 4A, Slow Blow for 100, 120 operation and 2.5A, slow Blow for 220, 240 operation.
To select line voltage, remove line cord and remove PC board.
Locate the marking of the desired line voltage and insert PC board so the appropriate line voltage marking is readable.
 - 24 Fuse -33Vdc, 5A Slow Blow
 - 25 Connector IEEE - 488, 1975 Standard Interface J34 (Option)
 - 26 Two Wire/Four Wire - Push Push Switch
Selects either function.
 - 27 Chasis Terminal.
 - 28 Connector Deviation BCD readout J16 (Option)
 - 29 Connector Model 750A J15
- NOTE:** Pushing any of the Function, Range, Frequency or Frequency Multiplier Switches for a new selection causes the Standby condition.

End Table 2-1

Front Panel - Controls and Indicators

In the resistance mode, resistances may be selected having the values of 1, 10, 100, 1000, 10K, 100K, 1M, 10M Ohms.

WARNING

The selection of inappropriate functions and setting and subsequent application of these setting to an instrument under test can damage it. The Model 710 has safety features to minimize this possibility. The selection of new ranges or functions, including + to - and major frequency changes, automatically place the Calibrator in the safe standby condition as is evidenced by the green standby button becoming illuminated. A change in voltage, current and frequency setting will not cause the standby condition. However once the Calibrator has assumed the standby condition output, can only be obtained by depressing the red operate switch. An additional safety feature is the illuminated high voltage indicator above the output terminals. High voltages sufficient to present a shock hazard to personnel are indicated by the illumination of this indicator. Another safety feature is the automatic standby condition upon power up to avoid the application of incorrect voltages or currents.

WARNING

The Model 710 is overload protected. A dc current at the power amplifier output greater than 5 amperes peak, or a voltage greater than 15 volts in the current mode, trips the Calibrator into the standby condition. The overload must be removed before the operate condition can be achieved again.

2.5 The Model 710 as a Precision Voltage Source

Inspect the Calibrator to insure the four wire connection is not chosen, which connects Output High to Sense High and Output Low to Output Sense Low terminals. The only time it should be necessary to use four wire connections is in the calibration of low impedance millivolt meters and low resistance ohmmeters. This situation is described below in paragraph 2.8. Apply power to the Calibrator by pressing the power switch in the lower right hand corner of the front panel; then press the voltage function, voltage range, the polarity or frequency and observe that the Calibrator is in the safe standby condition.

Attach the instrument to be calibrated to the Sense High and Low terminals, the red or high input lead to the red Sense terminal and the low input lead to the black Sense terminal. Set the instrument to be calibrated to the proper scale in the voltage function selected and depress the red Operate button on the Calibrator. The set value is now applied to the instrument under calibration. If the deviation display is blanked the deviation function is not activated. To determine the instrument error, activate the appropriate deviation range button and, using the deviation control, adjust the instrument to be calibrated so that it indicates the exact nominal value for which the Calibrator has been set. The exact % error of the instrument under calibration is now displayed in the % deviation display. The error is also available with certain optional equipment for data

logging.

The calibration of electronic meters having 100mV or even 10mV full scale is possible using the 100 millivolt or 10 millivolt range of the Calibrator. Since electronic meters usually have very high input impedance on these ranges (in excess of 1 meg ohm), the 10 Ohm output resistance of the Calibrator is of no concern and would not produce a measurable error. In no case should the four wire configuration be used at this time as serious errors could be encountered.

Scale linearity, of a digital instrument, may be easily checked by setting the most significant decade from 1 through X (10) and observing the deviation readings at each point. The operation of the digital display may also be checked by setting the Calibrator to 1111, 2222, 3333 etc and observing the display of the instrument under calibration. Further operation of digital meters at points above full scale is possible by the use of 10 positions.

Should a short circuit be inadvertently applied to the Calibrator, it would automatically assume the safe standby condition without damage except in the 10 and 100mV ranges where Standby will not occur. Once the short circuit has been removed the operate button may be depressed again to restore normal output.

2.6 The Model 710 as a Precision Current Source

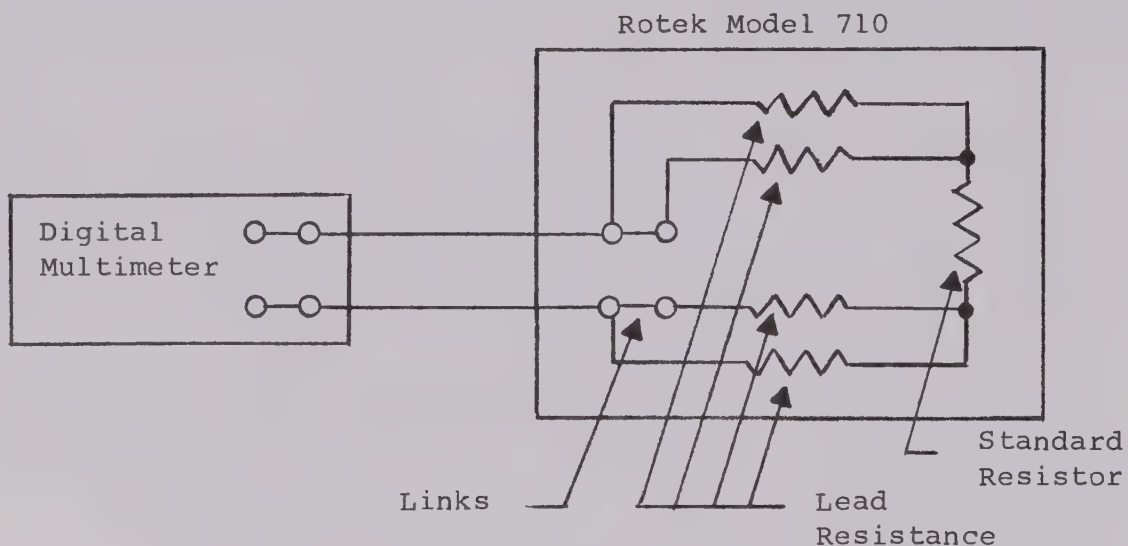
To operate the Model 710 as a precision current source press the Amps function button, select the range, polarity or frequency and the current setting as desired. Press the deviation OFF button. The Calibrator is now in the standby mode. Connect the instrument to be calibrated to the output terminals as described in paragraph 2.5. Make sure that the instrument to be calibrated is set to the proper range and mode. Press the Operate button and the Calibrator's output terminals are activated with the selected setting. The Model 710 is a current source with a maximum compliance of 5 Vdc or RMS so that variations in the lead resistance or poor connections do not affect the current output of the Calibrator. The reading error of the instrument under calibration may be determined by using the % deviation control and display.

Should the operator of the Calibrator inadvertently press a voltage function during current operation, the Calibrator is immediately placed in the standby mode so no damaging voltages will be applied to current sensitive circuits.

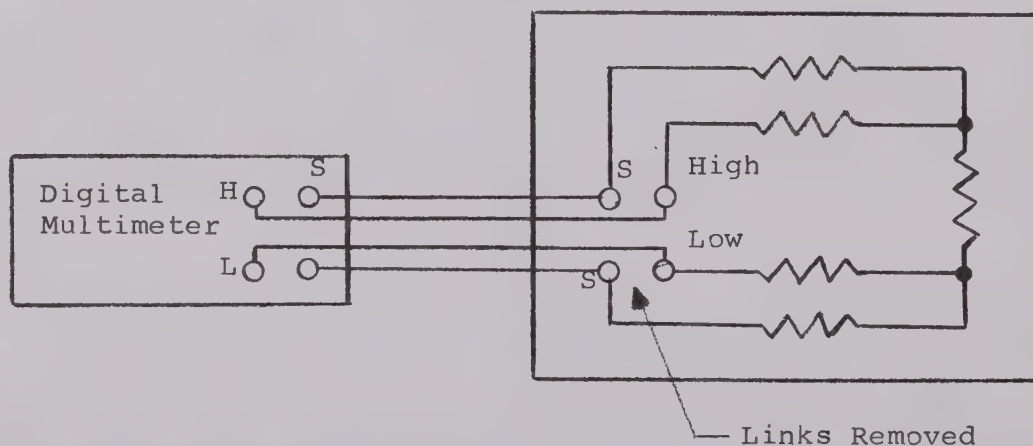
If the output leads are opened during the application of current to a meter, or too large an impedance is seen across the output terminals, the standby condition occurs automatically. As in a voltage overload the condition must be rectified before normal operation can again be achieved.

2.7 Model 710 Calibrates Resistance Scales of Meters

Operate the Model 710 by pressing the Ohms function button.



Two Wire Resistance Connection
Showing Effect of Lead Resistance
Figure 2-2A



Four Wire Resistance Connection
Figure 2-2B

Confirm that standby has occurred. In this mode of operation one of eight precision resistors is connected to the output terminals, the value being selected by the Ohms control. To connect the value selected the operate button is pressed. Operation of the ohms control does not affect the Standby/Operate status; so a sequence of resistance values can be selected and applied to the ohmmeter to verify all resistance ranges without going to standby between each different value. To avoid common mode voltages, which may cause erroneous readings, connect the Volt/Ohm meter low lead to the Calibrator's sense low (black) terminal.

If four wire sensing has not been selected, the precision resistor is available as a two terminal device. In this configuration lead resistance within the Calibrator is placed in series with the precision resistor and the sense terminals. This adds to the inaccuracy of the resistance as measured at the Sense terminals and results in the specifications of paragraph 1.4.6.1.

If four wire sensing has been selected, the precision resistors are available with a four wire connection (Fig. 2-2B) for voltage and current pairs. This configuration results in the least inaccuracy. However, the meter under calibration must have a four wire Ohms connection. The resulting specifications are given in paragraph 1.4.6.2.

NOTE: For the lowest noise and least series EMF set the Calibrator to +DC, 10V, 0.000 on decade dials.

2.8 Four Terminal Sensing (Not for use on the 10 and 100mV ranges)

Lead resistance can cause serious errors in the calibration of meters with low input impedance. For instance an instrument may have an impedance of 5 ohms. If two test leads with a resistance of 0.1 ohms each are used to check this meter, an unwanted 0.2 Ohms resistance is in series with the test meter, see for instance Figure 2-3A. If two terminal output connections are used, the voltage at the meter terminals will be low by 0.2V or 4% causing a very serious error in the indication of the meter being calibrated. This error can be eliminated through the use of four terminal sensing (See Fig. 2-3B). In this case the Calibrator's voltage Sense terminals are connected directly to the load being calibrated with two extra wires and the four wire switch is on. Two other wires are connected from the Output terminals of the Calibrator to the load being calibrated which supply the necessary current. The internal shorts, which were removed, are effectively being replaced by these two sets of leads going to and coming back from the load being calibrated. The series resistance of the drive leads will require a slightly higher terminal voltage at the Calibrator but will not affect overall accuracy.

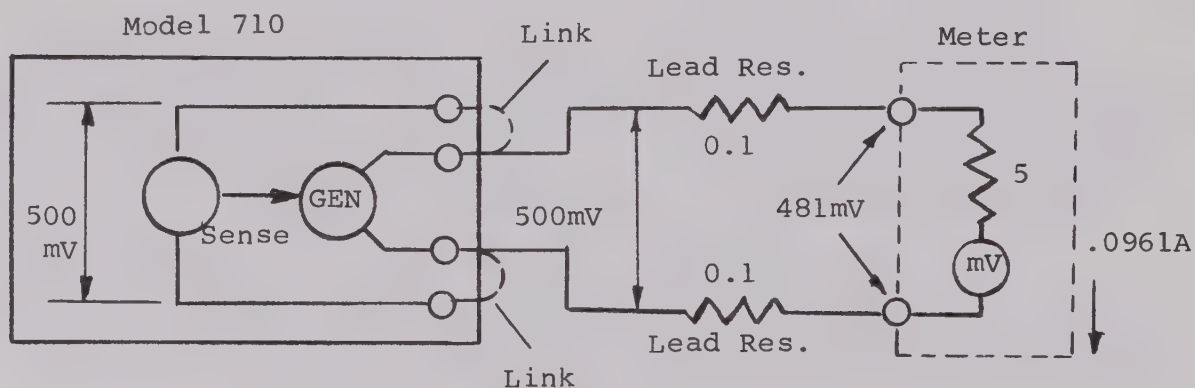


Figure 2-3A

Illustrating Lead Resistance Errors

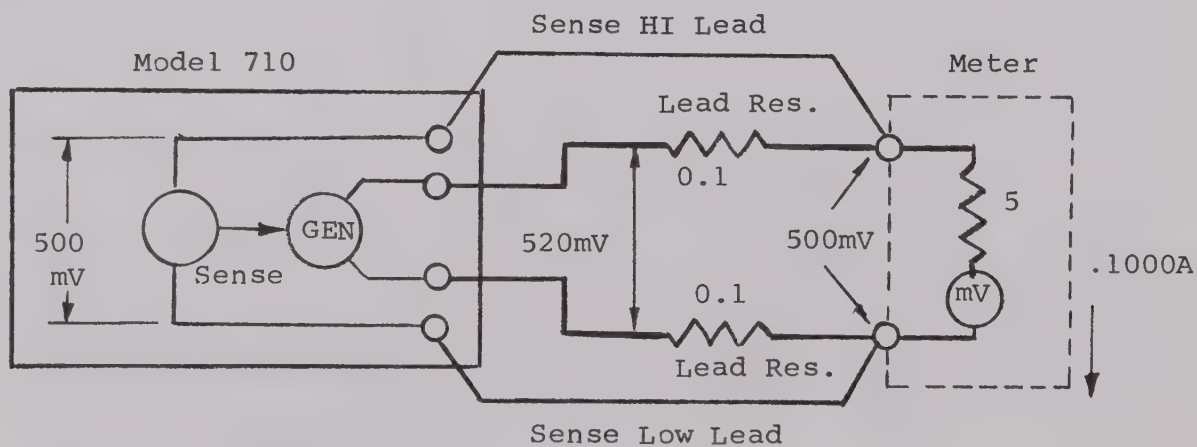


Figure 2-3B

Four Wire Connection
(10, 100, 1000 Volt Ranges)

SECTION 3

THEORY OF OPERATION

3.1 Purpose

The purpose of this section is to describe the operating principles and circuits of the Model 710.

3.2 Introduction

The Model 710 is a multifunction Calibrator having six basic configurations to provide the functions:

1. AC voltage
2. DC voltage less than 10 volts
3. DC voltage greater than 10 volts
4. DC current
5. AC current
6. Resistance

Variations of these configurations exist to provide negative dc voltage/current and voltages less than 100 millivolts.

To arrange the components in the six configurations, a logic interface is situated between the components and the front panel and remote controls. The basic configurations mentioned above are described in this paragraph (3.2). Paragraph 3.3 describes some of the components of these configurations, the Reference, the Oscillator, the Attenuator and the Analog switches. Paragraph 3.4 describes the detailed block diagrams of the six configurations and paragraph 3.5 describes the logic interface.

3.2.1 AC Voltage

Figure 3-1 shows the arrangement of components in the Model 710 for ac voltage. The basic components in this block diagram are:

1. A precision source of dc voltage called the reference,
2. A variable precision resistor called the attenuator,
3. An operational amplifier integrator,
4. A variable frequency voltage controlled oscillator,
5. A leveling circuit,
6. A power amplifier,
7. A precision rectifier.

Another part of the Calibrator shown in Figure 3-1 is the guard, which encloses the electronic parts, isolating them electrically from the chassis. The guard is connected to Sense Low. Also shown in Figure 3-1 are the output and sense connections which are described further below.

Operation is caused by injecting a current through the precision attenuator to the summing junction of the integrator. The integrator causes the voltage controlled oscillator to assume an amplitude which

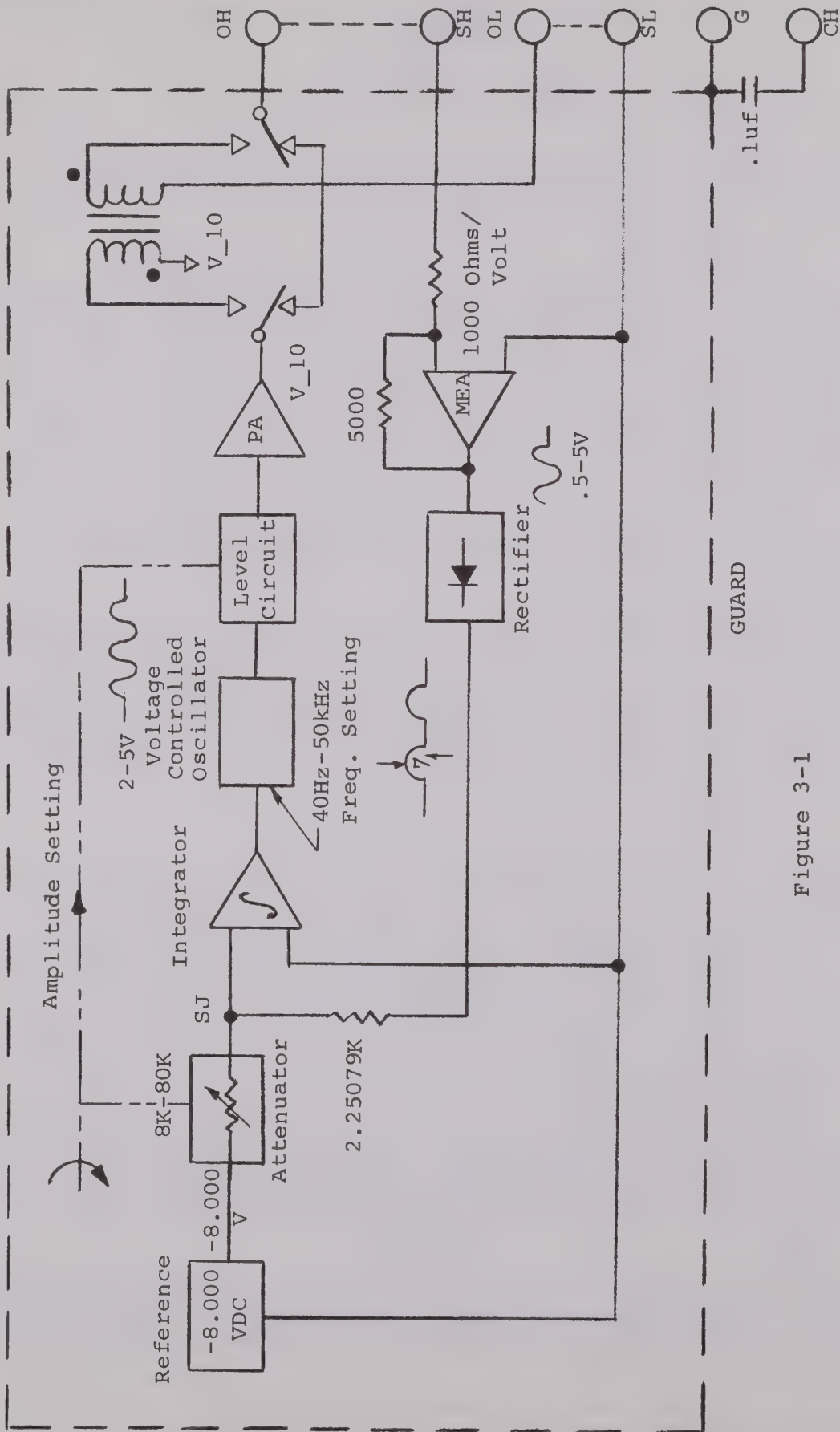


Figure 3-1
AC Voltage Simplified Diagram

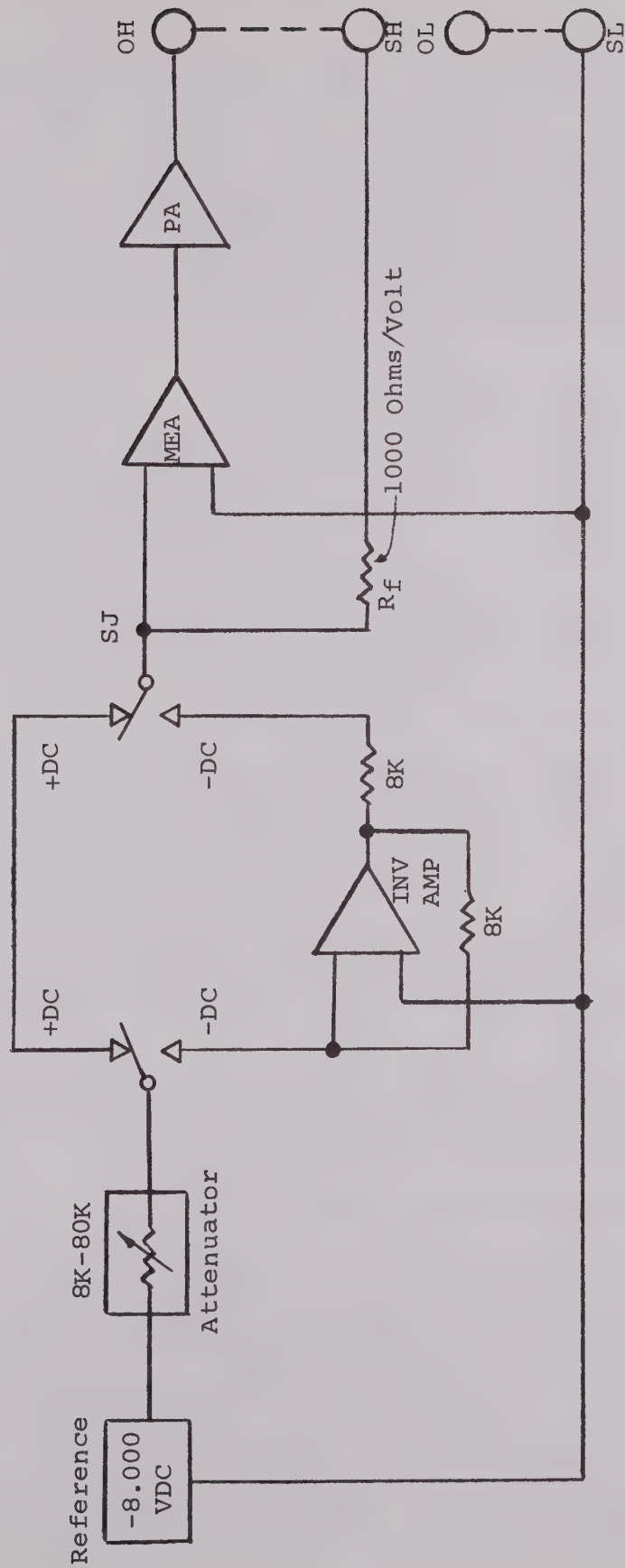


Figure 3-2

DC Voltage Less Than 10 Volts

Simplified Diagram

after passing through leveling circuits, power amplifier, output circuits, scaling resistor R_f and the precision rectifier is such as to cause an equal and opposite current at the summing junction of the integrator to that injected from the precision attenuator. The output is conducted directly from the power amplifier for voltages ≤ 10 volts rms, and is conducted through transformers to the power amplifier output for voltages > 10 volts rms. Resistance values and voltages are chosen such that 1 milliamperes equals full scale on any range, each range having a span of from 1 to 10. So the value of R_f for the 1 volt range is 1000 ohms, for the 10 volt range 10000 ohms and so forth.

3.2.1.1 Output and Sense Connections

The power amplifier furnishes sufficient current particularly on the lower ranges as to cause an error due to the drop in the leads going to a low impedance meter. The points that sense voltage (that is the connection to R_f) are connected to external terminals called the Sense High and Sense low. These terminals are available for a four wire connection to eliminate lead drop errors (see paragraph 2.8). In the majority of applications the lead drops are of negligible proportions and the Sense High and Sense Low are connected to the respective Output High and Output Low terminals by a relay.

3.2.2 DC Voltage Less Than 10 Volts

The simplified diagram of the configuration for dc voltage ≤ 10 volts is shown in Figure 3-2. As discussed above a precision current is injected to the summing junction (SJ) of an operational amplifier (MSA). The output voltage of the operational amplifier and the power amplifier assume values so as to cause an equal and opposite current to that injected above in the resistor R_f . The scale of currents, voltages and resistance is again such to make 1 milliamperes full scale on each range. The span of each range is again 1 to 10 so the value of R_f on the 1000 millivolt range is 1000 ohms and the 10 volt range 10000 ohms and so on.

In the negative dc mode the precision currents are injected into the summing junction from the reference and the attenuator via an inverter amplifier. This change in input polarity causes a change of polarity in the power amplifier output.

3.2.3 DC Voltage Greater Than 10 Volts

The arrangement of components is shown in simplified form in Figure 3-2 for dc voltages greater than 10 volts. As described in the preceding paragraph a precise current is injected from the reference to the summing junction (SJ) of an accurate operational amplifier (MSA). The MSA output voltage activates a combination of an integrator, voltage controlled oscillator and rectifier so as to apply a 5000Hz sine wave voltage through a leveling circuit to the power amplifier. The power amplifier output is connected through transformers to rectifiers and filters, to reproduce a dc voltage, and then to the output high terminal. The output high terminal assumes that voltage which causes a current through resistor R_f which is equal

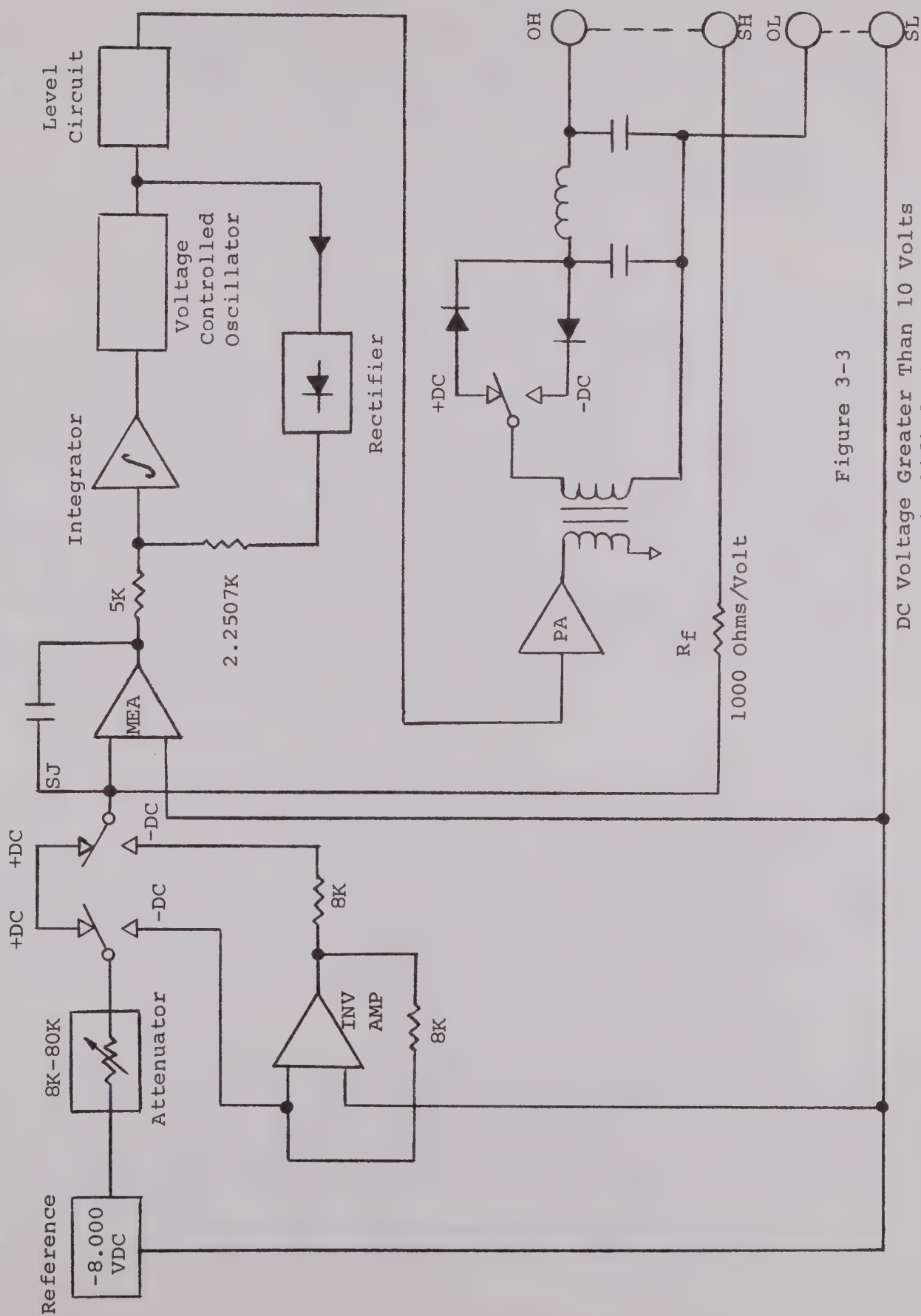
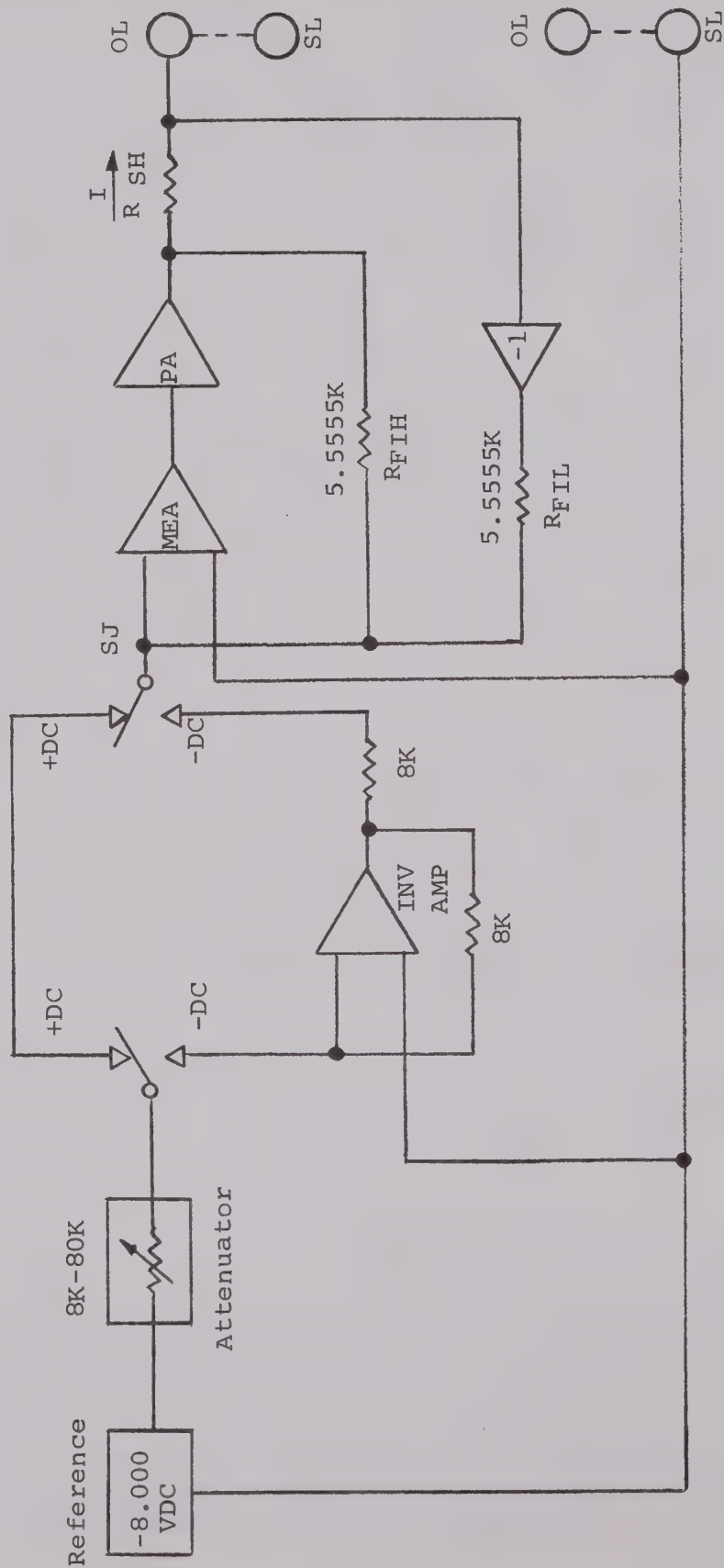


Figure 3-3

DC Voltage Greater Than 10 Volts
Simplified Diagram



and opposite to that injected previously from the reference through the attenuator. The transformers connected to the power amplifier output is a step up transformer providing either a full scale of 100 volts or 1000 volts depending on range selected.

The scale of resistance, voltage and current is such as to obtain 1 milliamperere full scale on each range. The span of each range is the same as previously described and the value of R_f is in turn relative to obtain the 1 milliamperere.

3.2.4 DC Current

The diagram for the arrangement of components for dc current is shown in Figure 3-4. A precision current is injected at the summing junction of an operational amplifier (MSA) through the precision attenuator. The output of the MSA is conducted to the power amplifier and then through a precision shunt resistor, R_{sh} . The power amplifier applies voltage such that the drop across the resistor R_{sh} produces currents in the two resistors R_{fil} and R_{fil} which balance the current injected into the summing junction as described above from the reference. Thereby a precise relation is established between the current, I , in the precision shunt and the current injected into the summing junction. The current I passes to the Sense High terminal through the external meters and to the Sense Low terminal. The current then returns to the power supplies which are not shown on the simplified drawings. The full scale current at the summing junction is 1 milliamperere and the full scale voltage across the precision shunt is 5.5555 volts. This results in values of R_{sh} of 5.5555 Ohms for the 1000 milliamperere range and 55.555 ohms for the 100 milliamperere range and so forth.

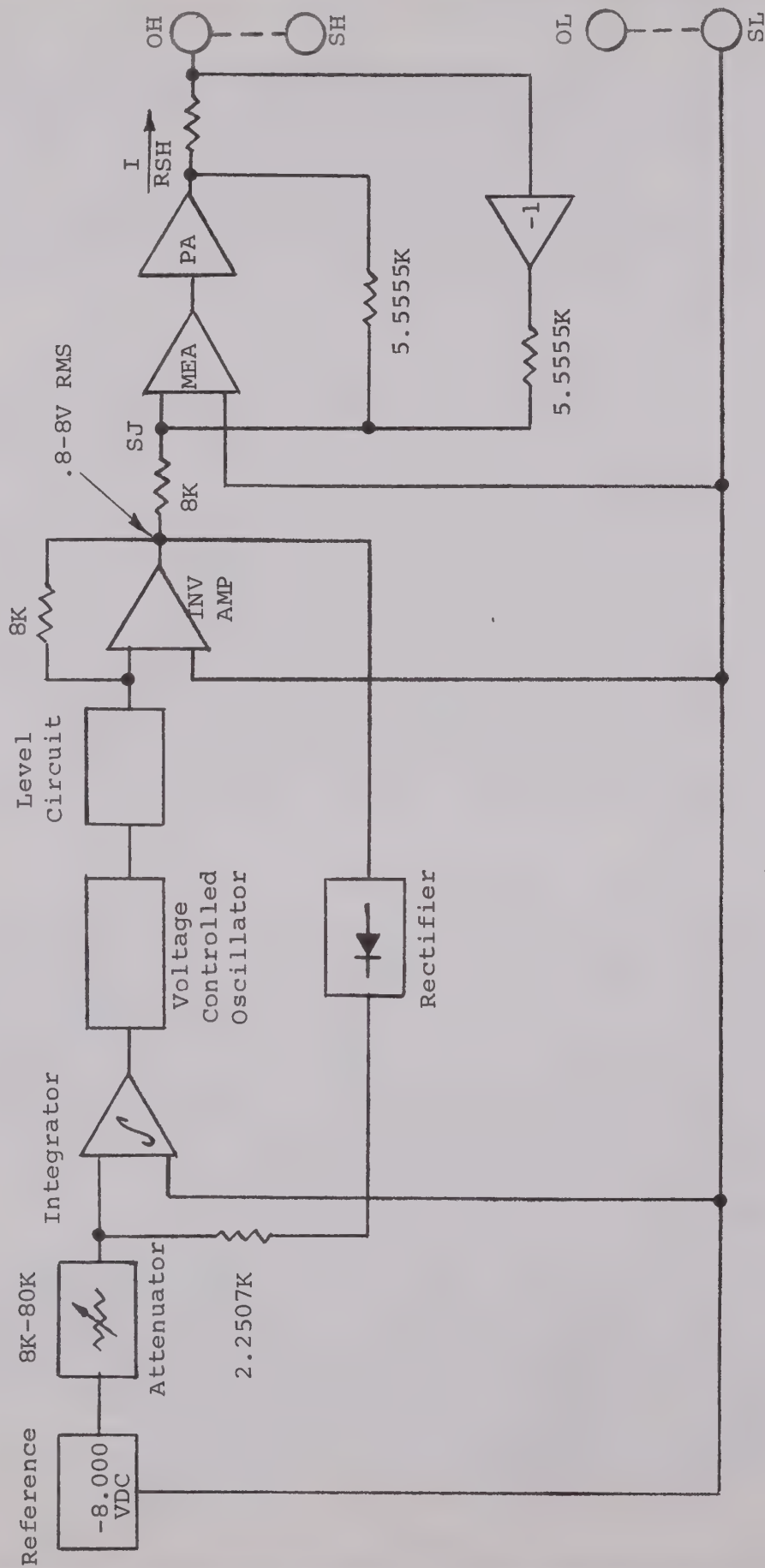
3.2.5 AC Current

The components are arranged as shown in Figure 3-5 for ac current. The reference and attenuator inject a current to the input of the integrator, which with the voltage controlled oscillator, leveling circuit, inverting amplifier and recitifier constitute a precision oscillator. The output of the inverting amplifier is an ac voltage scaled in accordance with the attenuator value. This scaled voltage is applied through an 8K ohm resistor to the summing junction of an operational amplifier (MSA), which with the power amplifier, the precision shunt described in the preceeding paragraph along with other components operates identically to dc current.

3.2.6 Resistance

Figure 3-6 shows the arrangement of a typical resistor configuration. Connections are made to the resistor such that the precise value is measured between Sense High and Sense Low terminals. Connection are also made to the resistor through Output High and Output Low terminals so that a current may be conducted to the resistor and the voltage developed across the resistor can be measured at the Sense terminals.

3.3 Elements of the System



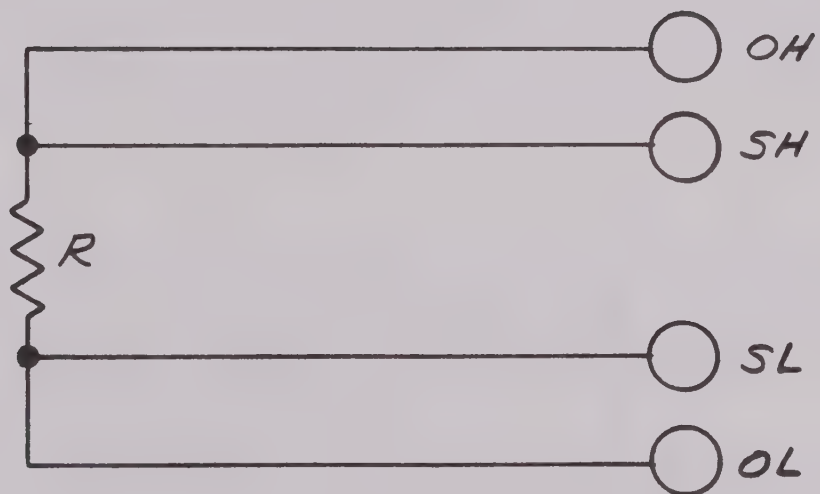


Figure 3-6

Resistance

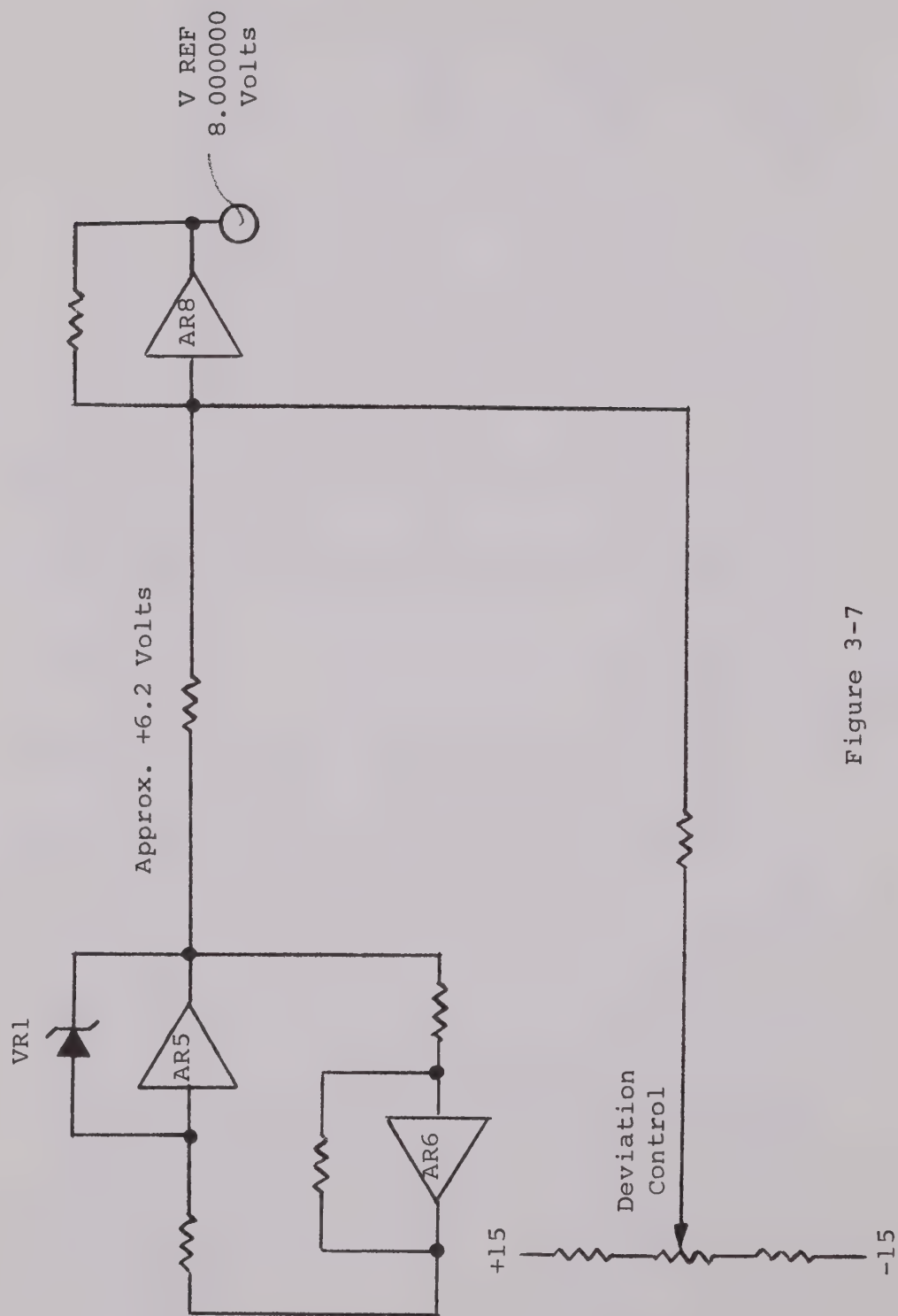


Figure 3-7
DC Reference

3.3.1 DC Reference

The schematic diagram of the dc reference is shown on drawing 07-117-001/2; a simplified representation is shown as Figure 3-7, Reference Circuit. The basic reference is a precision zener diode VR1 connected as the feedback element of operational amplifier AR5 to provide 6.2 volts $\pm 5\%$. VR1 is enclosed in a temperature controlled environment which maintains the temperature constant. The output of AR5 is scaled by AR8 to be precisely -8.0000 volts which is the reference voltage V_{ref} .

The Deviation control on the front panel is energized from the plus and minus 15 volt supplies. The output of the deviation control is conducted through the deviation scaling resistors to modify the reference voltage.

3.3.2 Voltage Controlled Oscillator

The schematic diagram of the voltage controlled oscillator is shown on drawing 07-115-001/1 and in simplified form in Figure 3-8. The oscillator is comprised of two integrating operational amplifiers AR1 and AR2 and an inverting amplifier AR3. The frequency is determined by the constants R and C according to the relation $F = 1/2 \pi RC$.

3.3.3 Attenuator

The attenuator as described in paragraph 3.2 above is a variable resistor which produces a scaled current at the summing junction of operational amplifiers. The scaling is accomplished to six decimal places in a 1-2-4-8 binary coded decimal form. Figure 3-9 shows a simplified schematic of the attenuator. The actual schematic of the attenuator is shown in drawing 07-115-001/2.

The six binary coded decimal digits are arbitrarily labeled the 10's decade, the 1's decade, the .1's decade and the 30 on to .0001's decade. The four resistors of the 10's decade produce currents of 0.8, 0.4, 0.2, and 0.1 of full scale current. These currents are applied to the summing junction by connecting the terminals of the switches marked S in series with each of the 10's decade resistor. For example if the switch in series with the 80K Ohm resistor of the 10's decade is closed, and all other switches are open, a current corresponding to 0.1 of full scale is produced; and in this case the output of the Calibrator would assume 1/10th of full scale on whichever range was selected, and so forth for all other resistors and switches. The resistors of the 1's decade have values 10 times those of the 10's decade and therefore cause a corresponding contribution of current of 1/10th of that of the 10's decade resistors. Otherwise their function is the same. The resistors of the 0.1's decade have the same values as those of the 10's decade but are connected to the summing junction of the amplifier through a further fixed attenuator so that their contribution to the overall current is .01 of that of the 10's decade resistors. This is shown symbolically in the diagram. In like manner the resistor in the .0001's decade produce currents .0001 of that of the 10's decade.

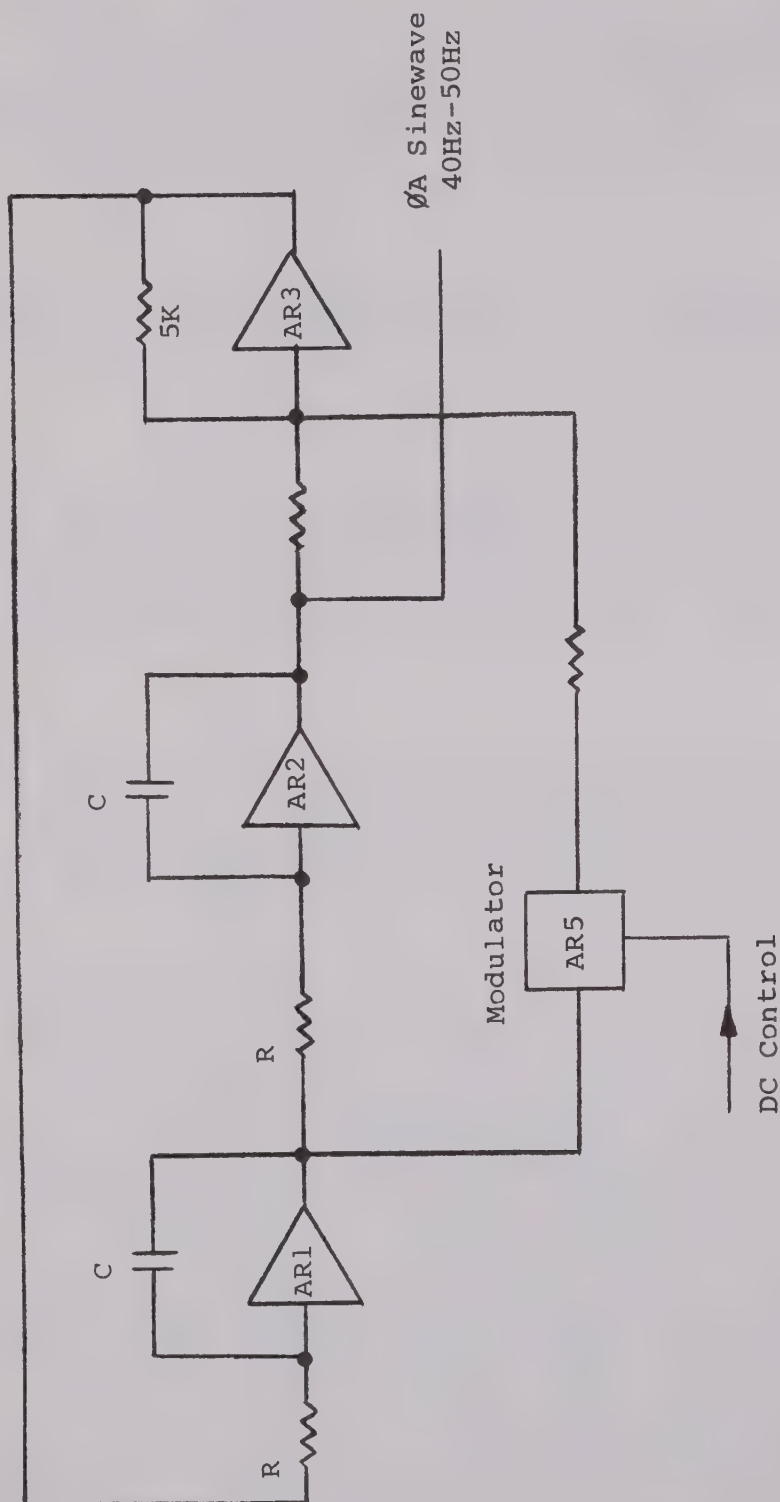


Figure 3-8
Voltage Controlled Oscillator

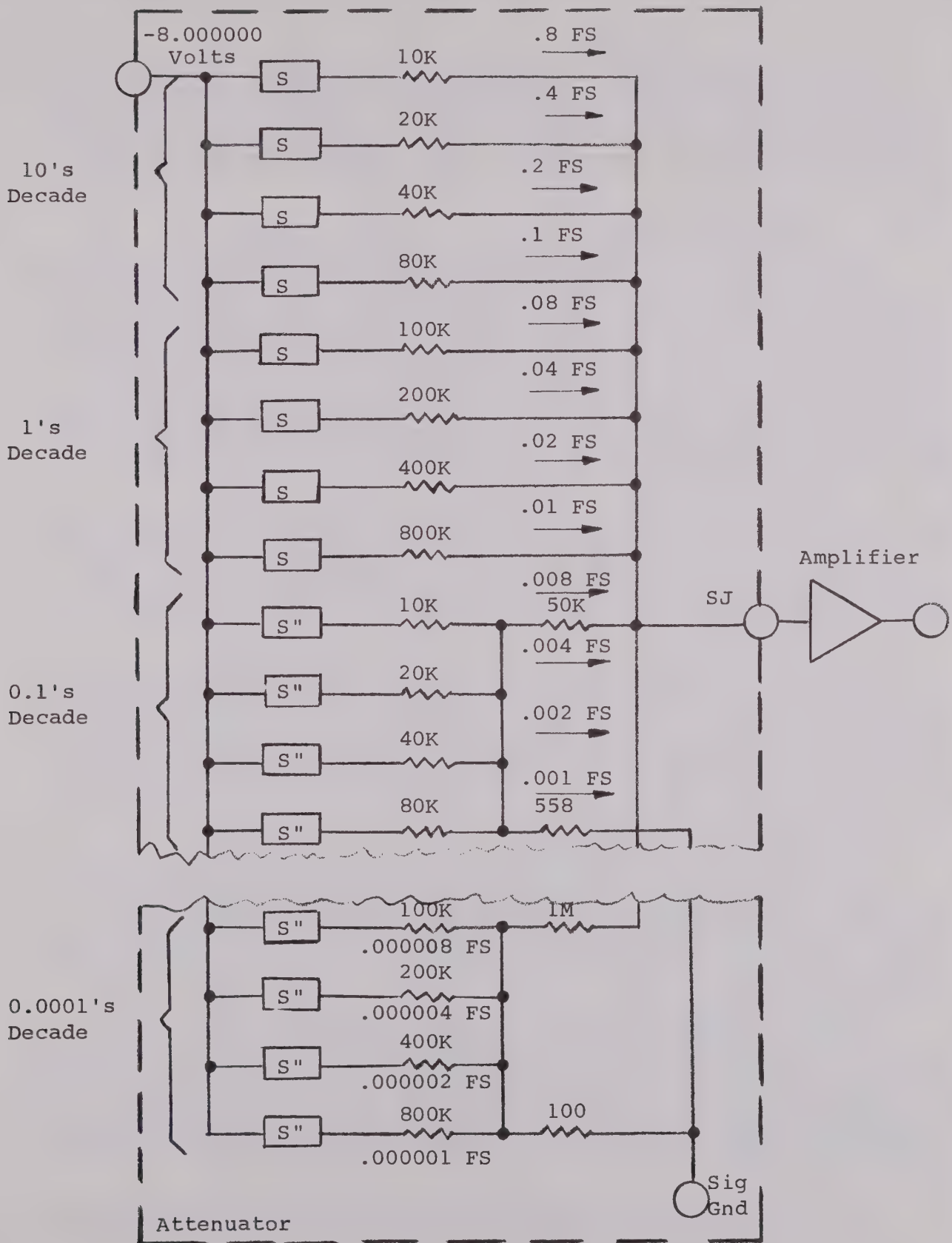


Figure 3-9
Attenuator

resistors.

It is thus possible to achieve resolutions of 0.000001 of full scale and to produce currents which vary in magnitude from 0.000001 of full scale to full scale and beyond if all switches are closed. In the Model 710 the arbitrary limit of 111.11% of full scale has been chosen. This is derived by closing three switches for the 8's and 2's digit in all decades.

3.3.4 Analog Switches

The switches marked S and S'' in Figure 3-9 are not mechanical contact switches, but are rather semiconductor switches controlled by logic level inputs. This type of switching is used because of its reliability and being compatible with the remote control features of the Calibrator. Other functions in the Calibrator are switched by means of semiconductor switches. The switches used are shown in Figure 3-10. The switch of Figure 3-10A is a series analog switch. The switch is open when the logic input level is high (greater than two volts) and the switch is closed or shorted when the logic level is low (less than 0.5 volts). Levels which are TTL compatible.

Figure 3-10B shows a switch which may be placed in series and provides for a shunt closure to ground. This switch is used as the switch marked S'' in Figure 3-9. The series switch and the shunt switch of Figure 3-10B have complimentary functions. The series switch is closed as stated above and the shunt switch is open under the same condition.

In some instances the characteristics of transistors used as the series element in the switches designated S2B and S1B are detrimental, and FET transistors must be used instead. A series FET analog switch is shown as Figure 3-10C. This type of switch is used primarily in series with resistors at the summing junction of operational amplifiers, where the analog voltages are likely to be quite small.

3.4 Signal Flow Diagrams

Six signal flow diagrams are provided as drawing number 07-600-002/1, /5, /2, /3 and /6. Corresponding to the simplified block diagrams of Figures 3-1 through 3-6 and described in section 3.2 above. The signal flow diagrams are provided to show in detail the important scaling and switching functions, adjustments, part locations and pin numbers.

Drawing number 07-600-002/1 shows the signal flow for ac voltage; the forward flow of signal is shown by a heavy solid line, and the sense or control lines are dotted. The forward flow is from the reference through the attenuator, the integrator, oscillator power amplifier and output switching circuits. The control or sense flow is through the sense path selecting circuits, the main summing amplifier and the rectifier.

If a relay must be energized to operate in the ac voltage mode, the function causing its operation is described next to the relay.

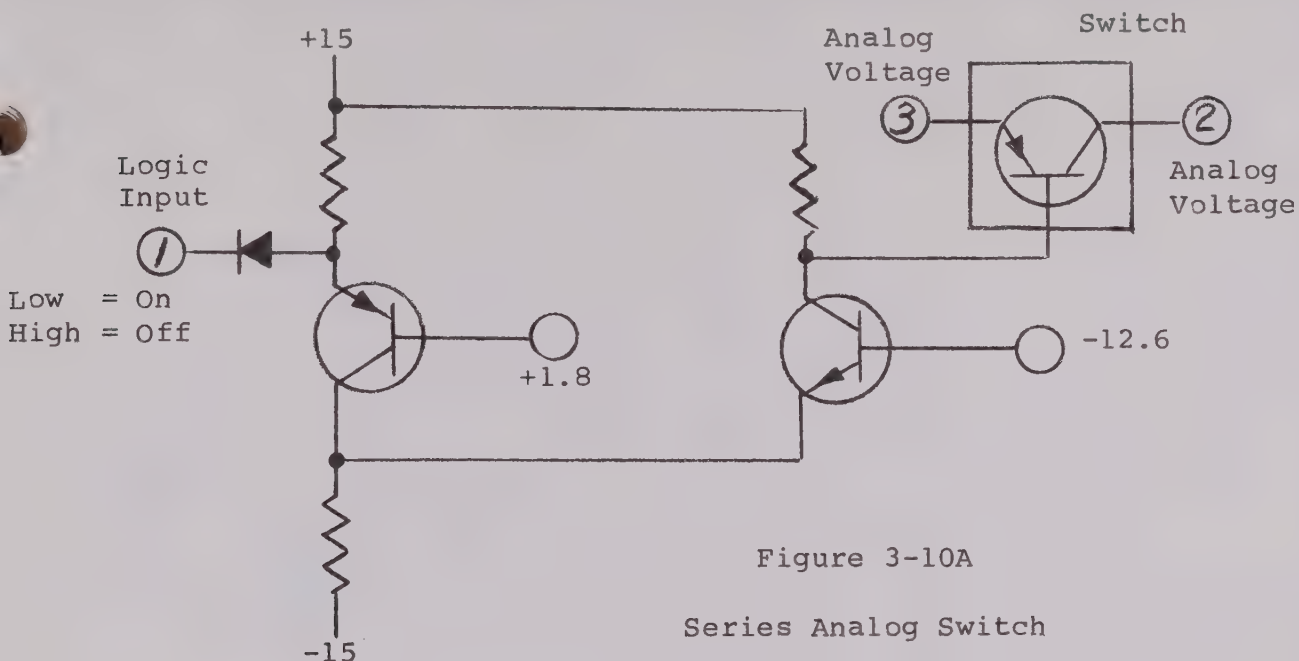


Figure 3-10A

Series Analog Switch

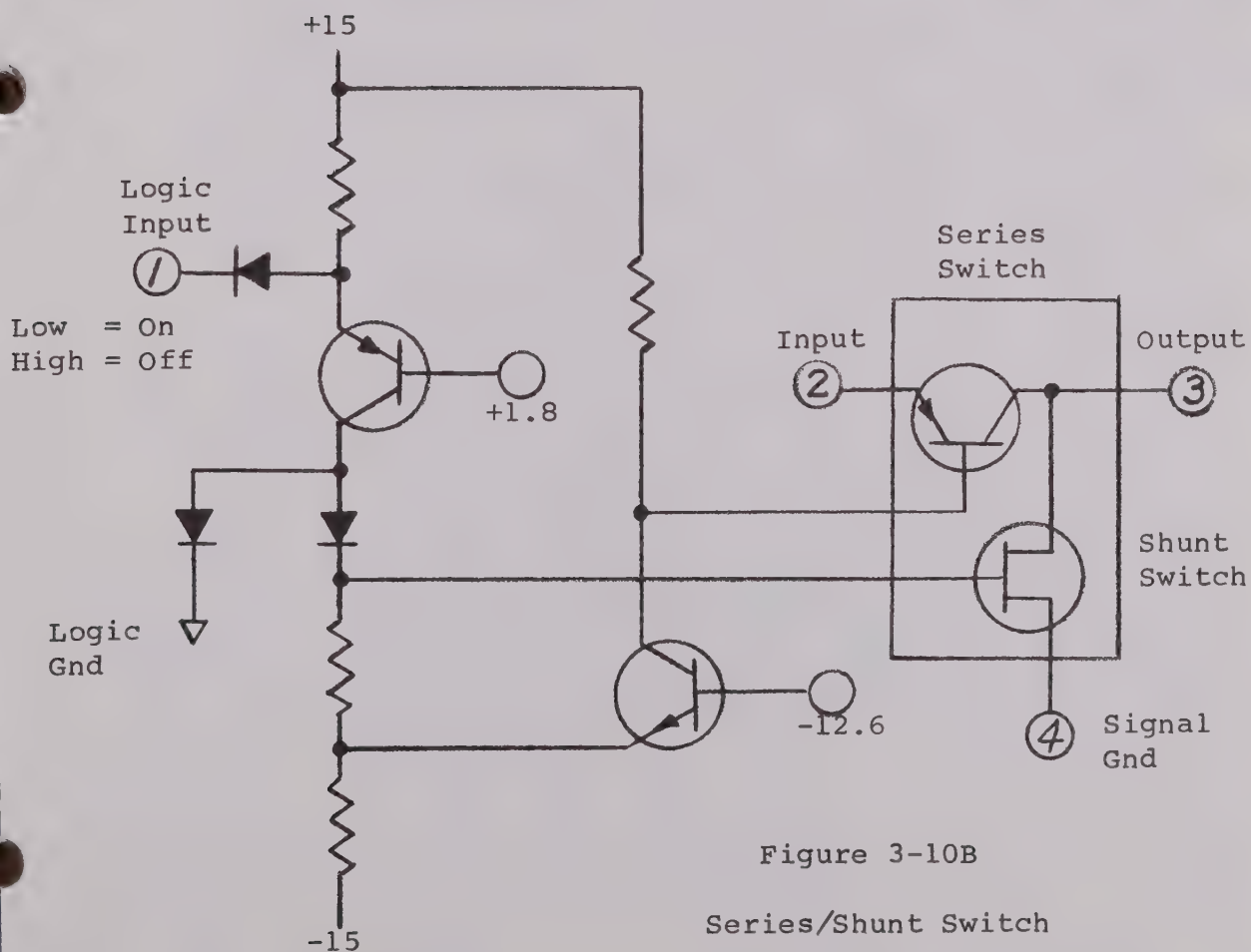


Figure 3-10B

Series/Shunt Switch

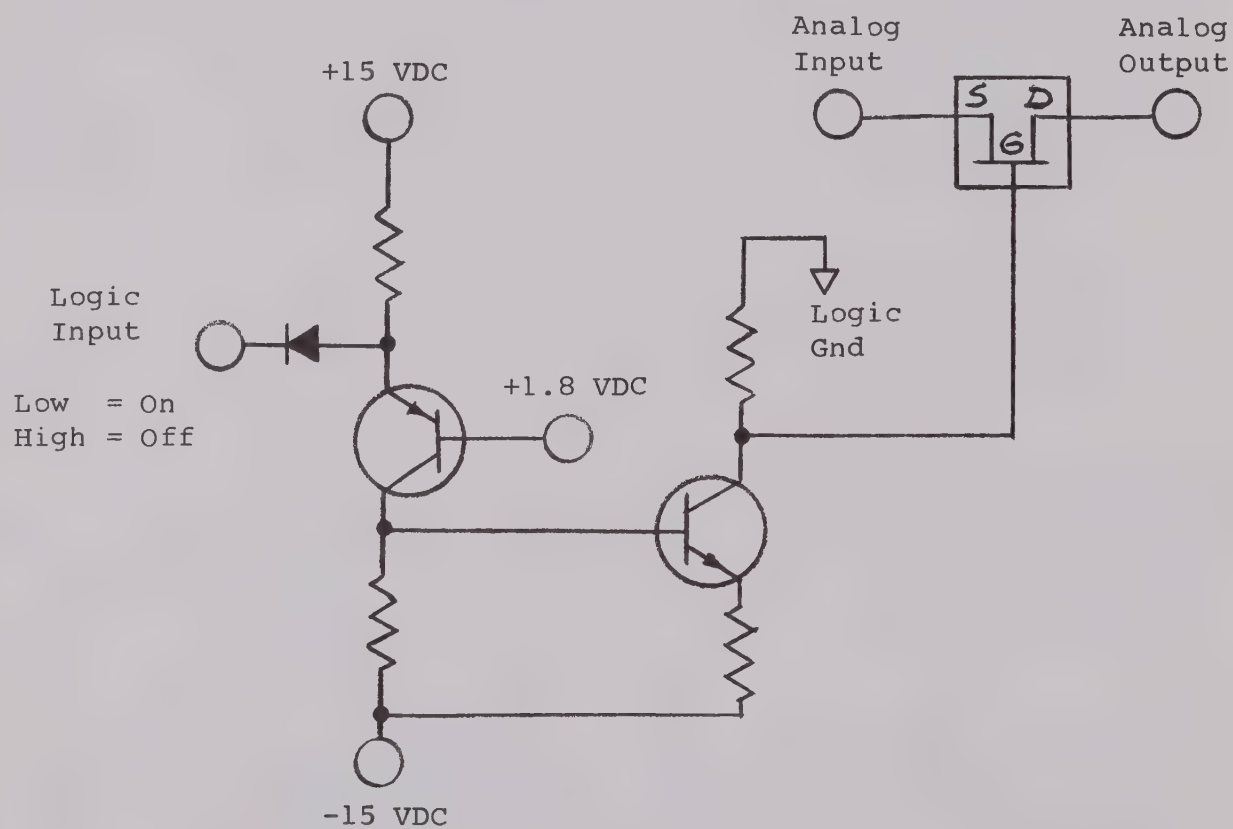
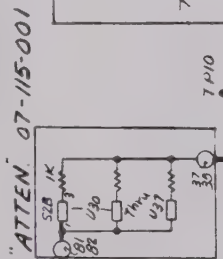
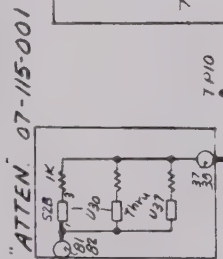
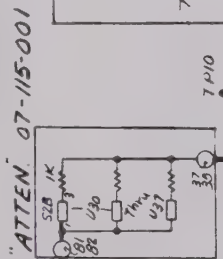
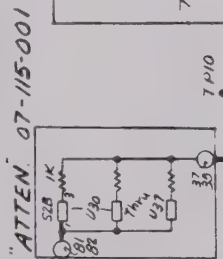
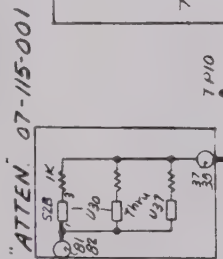
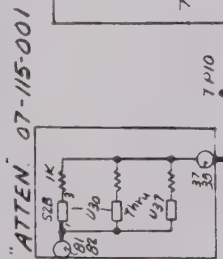
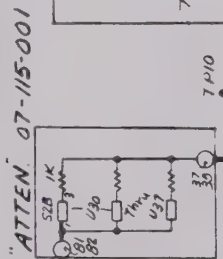
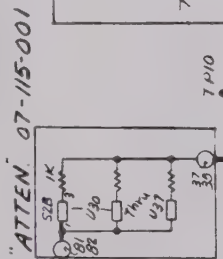
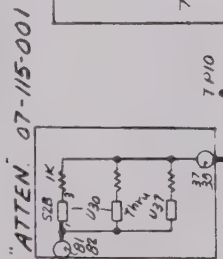
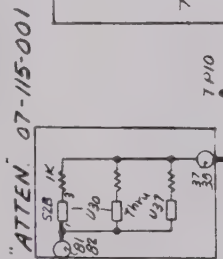
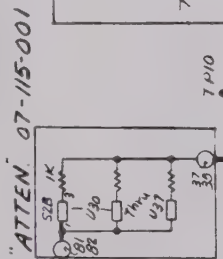
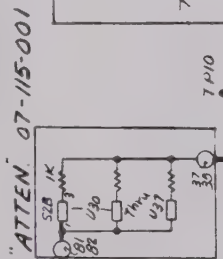
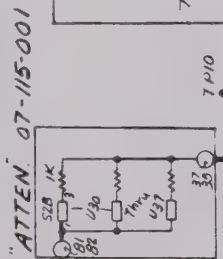
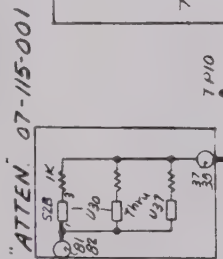
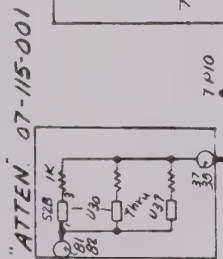
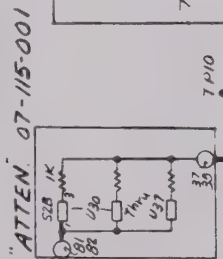
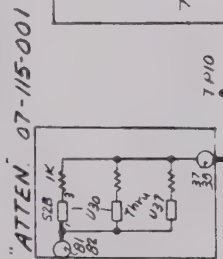
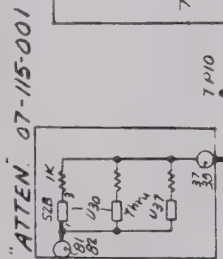
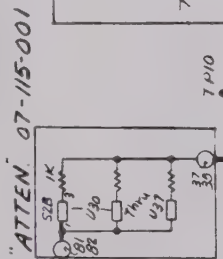
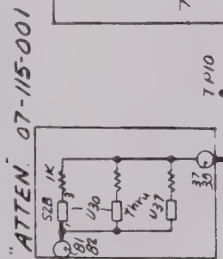
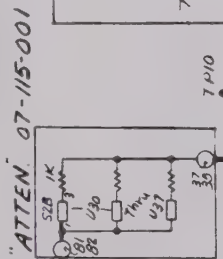
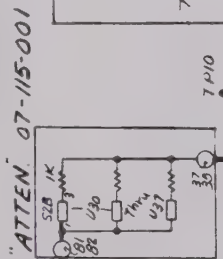
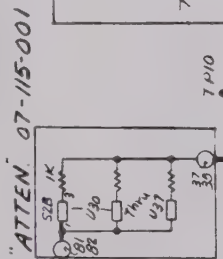
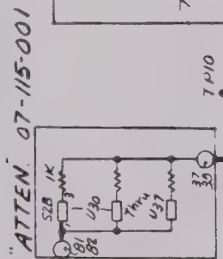
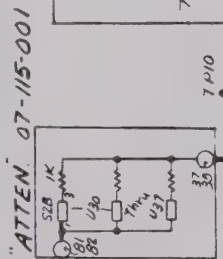
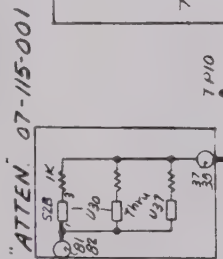
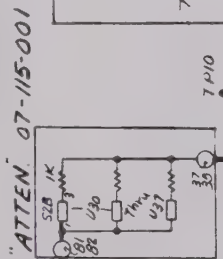
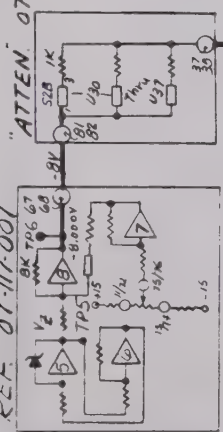
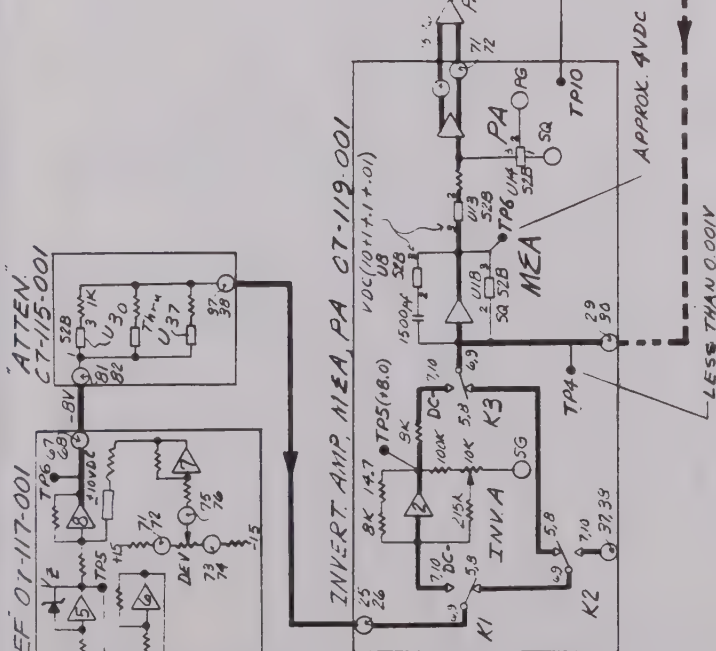
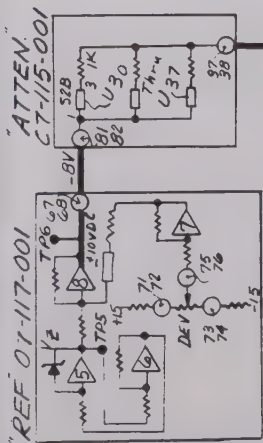


Figure 3-10C

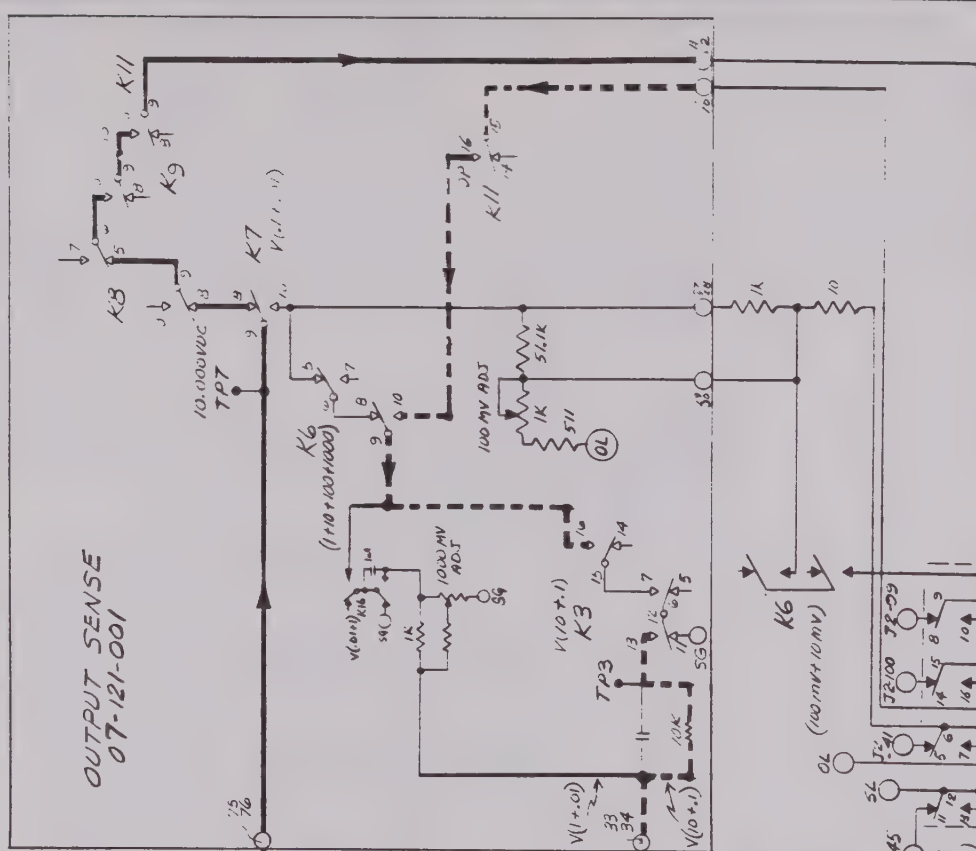
Fet Series Switch

"REF" 07-117-001





OUTPUT SENSE
07-121-001



VOLTAGES SHOWN ARE SETTING OF 10.000 VOLTS DC

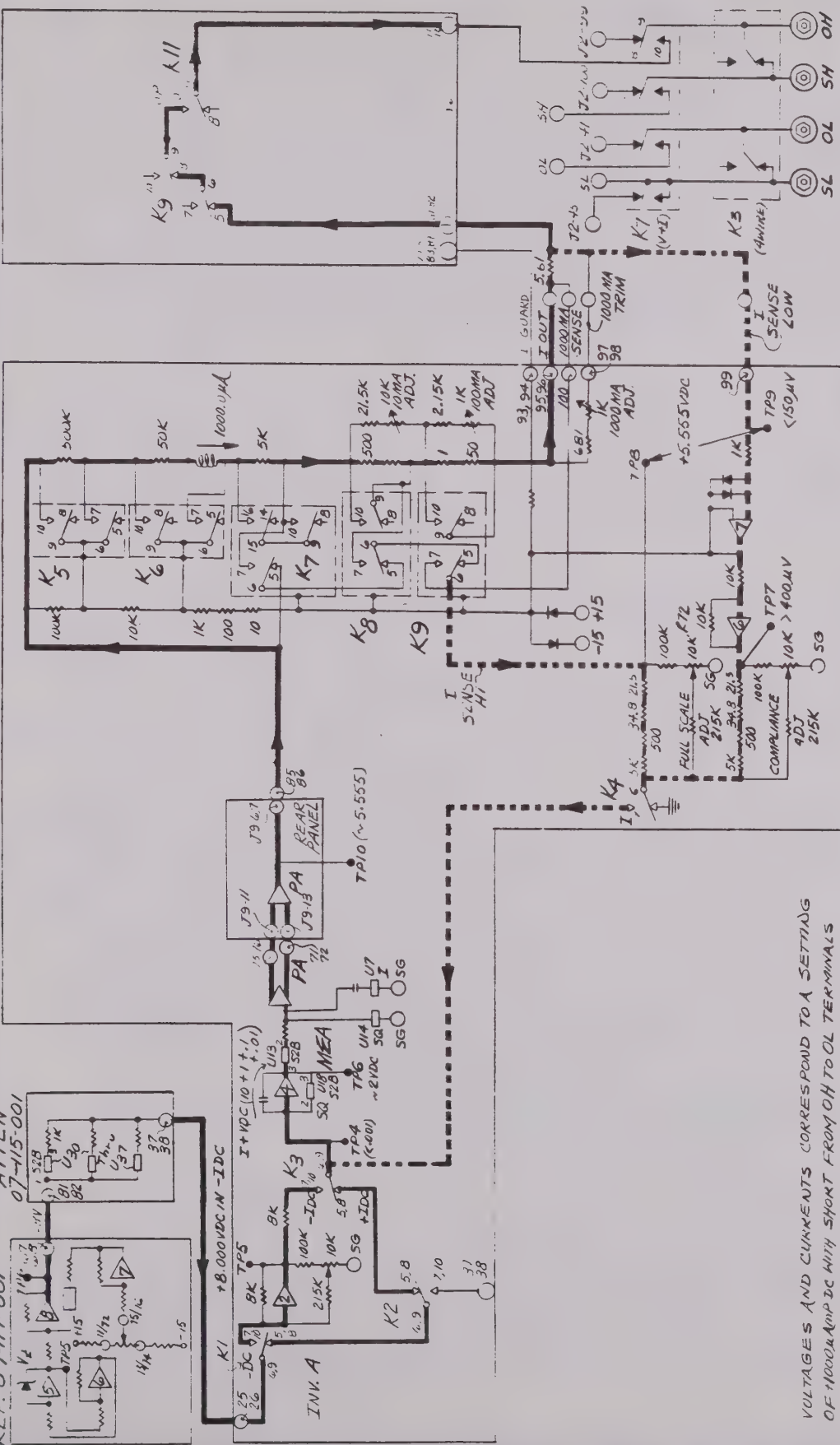
SCALE	DATE	APPROVED BY	REVISED BY
2-28-84	2-28-84	h. h. h.	h. h. h.
ROTEK INSTRUMENT CORP.			
LOCAL TIME NUMBER SW'S			
DC VOLTAGE			
07-600-002			
LESS THAN 10 VOLTS			

OUTPUT SENSE 07-121-001

"CURRENT CONTROL 07-119-001

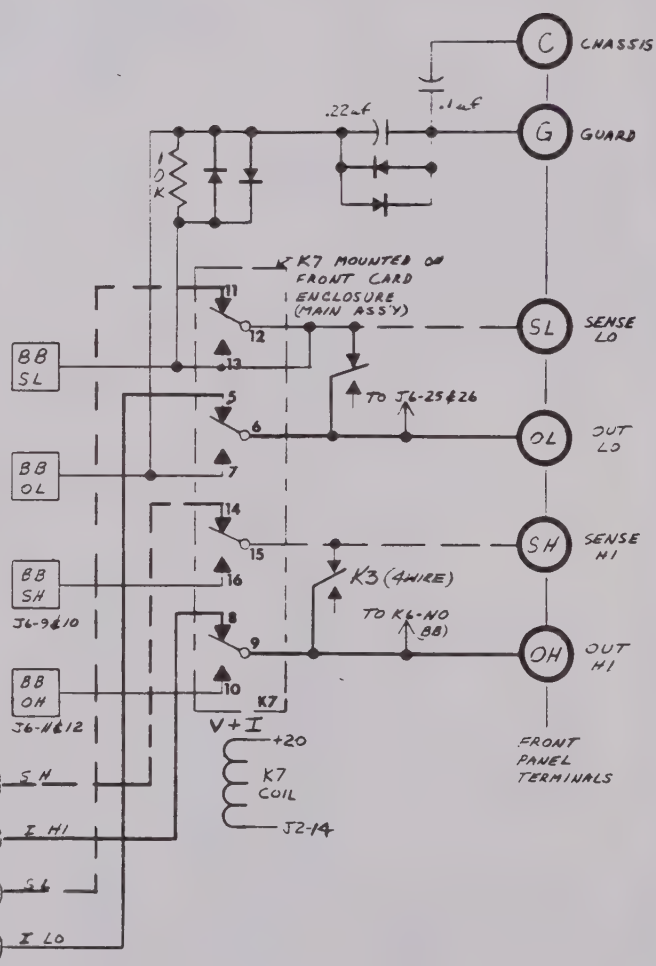
"ATTEN" 07-115-001

"REF" 07-117-001



VOLTAGES AND CURRENTS CORRESPOND TO A SETTING OF 1000uAmp DC WITH SHORT FROM OH TO OL TERMINALS

DATE	2-28-84	REVISED	10	ANAL. 710
DATE	2-28-84	REVISED	10	ANAL. 710
ROTEK INSTRUMENT CORP.				
D.C. CURRENT				
07-500-002				



SCALE 	APPROVED BY	DRAWING BY <i>RCD</i>
DATE <i>3-1-84</i>		<i>710</i>
<i>ROTEK INSTRUMENT CORP.</i>		
<i>RESISTANCE</i>		<i>SMT 6</i> DRAWING NUMBER <i>07-600-202</i>

For example the relay K2 of 07-119-001 is marked with the legend AC to show that K2 must be energized for ac.

Drawing number 07-600-002/5 shows the signal flow for dc voltage less than 10 volts. The forward flow of signal is from the reference through the attenuator, the inverting amplifier, the main summing amplifier, the power amplifier and then to the output. The feedback or sense flow is from the output through the scaling resistor directly to the main summing amplifier summing junction. Operation on the 10 and 100 millivolt ranges is accomplished by switching the sense or feedback connection through relay K6 to the top of the millivolt divider consisting of a 1000 ohm and a 10 ohm resistor. The output is connected from the top of the 10 ohm resistor through relay K7 to the Sense high terminal.

The signal flow for dc voltages greater than 10 volts is shown on drawing 07-600-002/2. In this case the forward flow is from the reference through the attenuator, the main summing amplifier, the integrator, the oscillator, the power amplifier, the transformers, the rectifiers and filters to the output. The feedback or sense path is from the output through the scaling resistors directly to the main summing amplifier.

The dc and ac currents signal flow are shown respectively on drawings 07-600-002/4 and /3. They follow the description given above in paragraph 3.2

Finally the diagram for the resistance mode is shown in drawing 07-600-002/6.

3.5 Control Interface

The control interface connects logic signals from the front panel or remote input to arrange the configuration, settings and frequencies of the Calibrator. The interface has three functions.

1. Multiplexing between front panel control signals and remote control signals,
2. Timing for the entry of range, setting and operate/standby data,
3. A logical manipulation to generate specific instructions for parts of the Calibrator.

In discussing the interface function the assertion of a control signal is defined as the low level, and conversely negation is the high level.

3.5.1 Multiplexing

Multiplexing between the front panel control signals and the remote control signals is accomplished in the multiplexer module by 13 dual four input 74S157N multiplexers controlled by the front panel remote selector push button. This is shown schematically on drawing 07-111-000/3 and /4. It may be seen that the output terminals of most of these multiplexers are connected to quad latches which hold the

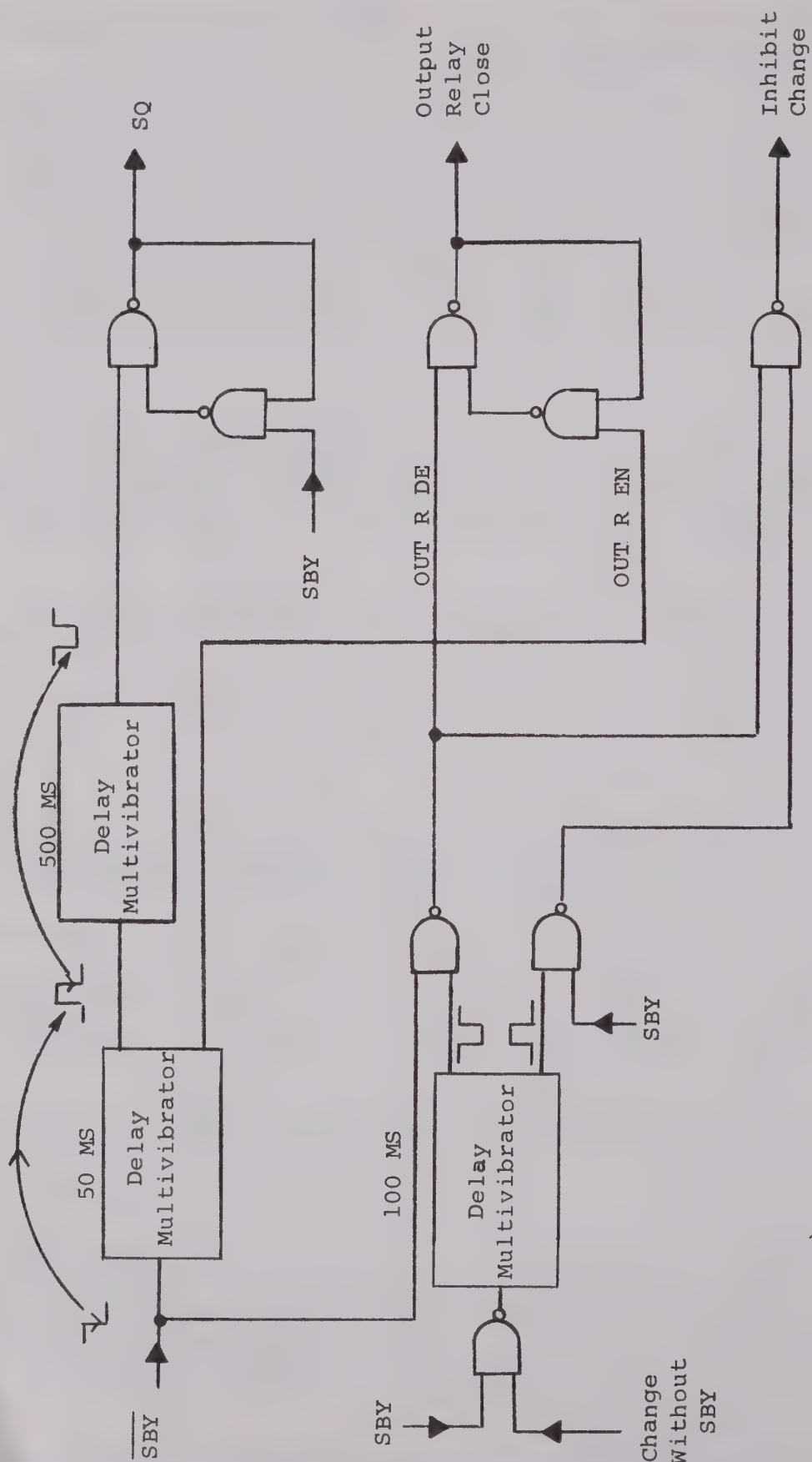


Figure 3-11
Timing Simplified Diagram

multiplexer outputs at the levels present when the INHCH signal is applied (Inhibit Change).

3.5.2 Timing

A simplified diagram of the elements of timing is given in the Figure 3-11. There are three basic outputs or signals from the timing which are:

1. The squelch (SQ) which interrupts all analog signals in the Calibrator.
2. The output relay control signal which closes the output relay thereby connecting the Calibrator to the output terminals.
3. The inhibit change (INHCH) signal which prevents any function or range from changing.

There are three signals which initiate timing output signals:

1. The leading (falling) edge of the standby (SBY) signal,
2. The leading (falling) edge of the change without standby signal.
3. The leading (falling) edge of the not standby signal.

Whenever the SBY signal is asserted it immediately effects the SQ signal, causing the quiescent zero condition of the Calibrator. Simultaneous the assertion of SBY and the negation of NOT SBY causes the assertion of OUT R DE 100 milliseconds after the assertion of SQ. This time delay before the de-energizing of the output relay is to insure that the output relay does not interrupt high voltage or high current. The signal INHCH is asserted as long as NOT SBY is asserted and for an additional 100 milliseconds after NOT SBY. This time delay prevents changes of configuration as long as there are high voltages or currents flowing in the Calibrator.

When NOT SBY is asserted (to enable operate) the 50 millisecond delay multivibrator is triggered immediately energizing the output relay via OUT R EN. After a delay of 50 milliseconds NOT SQ is enabled allowing the Calibrator output to build to its final value. The delay of 50 ms is provided to allow all transitions to a new configuration to occur before allowing the build up of high voltages or currents within the Calibrator.

If the Calibrator is in the condition Operate, NOT SBY is asserted, the assertion of CHANGE WITHOUT SBY causes a 100 millisecond interval during which INHCH is negated allowing certain changes to be made to the configuration of the Calibrator. This mode of operation occurs only during the transfer between Hz and Hz x 10 and Hz x 100 and Hz x 1000 and visa versa. The full implementation of timing function is shown in schematic 07-111-001/4.

SECTION 4

MAINTENANCE

4.1 Purpose

This section describes performance test, the calibration procedures and trouble shooting techniques.

4.2 Test Equipment

The equipment required to maintain the Series 710 is listed in Table 4-1. Equipment may be substituted based upon the equivalence of performance specifications.

4.3 Performance Test

Performance test may be used to verify instrument adherence to specifications either for periodic maintenance or at incoming inspection. The performance tests are conducted with a nominal line voltage $\pm 5\%$, 50-60 Hertz at a temperature of $23\text{C} \pm 1\text{C}$, at a relative humidity not greater than 50%. A performance check list is provided as Table 4-2; this check list may be copied and entries made on it to maintain a record of periodic inspection. The performance list designates a limited number of test points which are believed to verify specifications.

4.3.1 Front Panel Controls, Displays, Terminals

Turn power on and observe that the Standby light is on regardless of the position of any other control. Make no connection to the output terminals.

Push the button marked VOLTS/MILLIAMPS 10; the Standby lamp is on. Connect a multimeter arranged to read ± 10 volts dc as shown in Figure 4-1 to the output terminals of the Model 710. Push the buttons Volts, Deviation Off, +DC, establish a dial setting of X.000. Push the Operate control and observe the reading on the multimeter to be approximately 10 volts.

Push the AMPS button, observe that the Calibrator is in Standby; select the 10 milliamper scale on the multimeter and push the Operate control, observing that the multimeter reads approximately 10 milliamperes. Push the 10 Amps button and observe that the Calibrator is in Standby. Push the Operate control and observe that the meter reads approximately 10 milliamperes (this checks the operation of the unit should the 10 amp accessory Model 750 be attached at a later date),

Push the Ohms select button and observe that the Calibrator is in Standby. Select the 1000 ohm setting of the Ohms control and arrange the multimeter to read ohms on a scale suitable for 1000 ohms. Push the Operate button and observe that the meter reads approximately 1000 ohms.

Table 4-1

List of Equipment to Inspect and Calibrate

Rotek Model 710 Wide Band Calibrator

Instrument Nomenclature	Specifications	Use	Manufacturer and Model No.
Standard Cell with Enclosure	DC Standard Voltage +5uV traceable to NBS	Reference	Eppley Lab. Model 121
DC Voltage Standard	10 Volts, Short Term Stability $\pm 5\mu\text{V}$	Stable Source	PPM Ltd. Model 412
Voltage Divider	7 Place Decade Divider	Voltage Attenuator	John Fluke 720A
Volt-Ohm Box	5 PPM Resistance from 0.05 ohm to 10M ohm in steps	Attenuator & Current Shunt	ESI Volt Ohm Box Model 1063
DC Meter	Most Sensitive Scale: 1uV max. Full Scale 2% Accuracy F.S. Zero Center	Null Detection	Keithley Instr. Model 155
Distortion Meter	Voltage Range 1-300V Distortion Range .02% - 100% 50-600Hz	Distortion Measurement	Hewlett Packard Model 333A
AC Voltmeter	0.5 - 1000 Volts 0.005% Accuracy	AC Voltage Measurement	Holt Instr. Lab. Model 6A
AC Voltmeter	RMS Differential Voltmeter 10mV to 1000V	AC Voltage Measurement Low Voltage	John Fluke Co. Model 931
Precision Resistors	0.1 ohm $\pm .0005\%$ at 1 amp 1, 10, 100 Ohms ± 1 ppm	Current Measurement Measure Resistance	Leeds & Northrup Model 4221-B L & N Models 4020B-4025B-4030B
Oscilloscope	AC & DC 5mV Sensitivity	Observe Wave Forms	Tektronix, Inc Model 7603B Plug In 7A1B, 7B50A
Multimeter	AC & DC Voltage Current & Resistance	Measure Voltage, Currents, Resistance	Beckman Instr. Model 300

Table 4-1
(Continued)

Instrument Nomenclature	Specifications	Use	Manufacturer and Model No.
Counter	5Hz - 100kHz 5 Digit 0.01%	Measure Frequency	Hewlett Packard Model 5314A
DC Current Source	1uA - 100mA; 10 ppm short term (10 min.) stability	Measure Resistance	Rotek Instrument Model 710
Current Shunt	+0.02% AC - DC Difference	Measure AC Current	Holt Instr. Lab. Model HCS-1 1 Amp, 10 mAmp
	250 Ohms +0.01% 5 pf shunt capacity	Measure AC Current	Vishay Resistance Products Co. S102
Resistors	±5%	Loads	
5 Ohm 10W			
100 Ohm 10W			
200 Ohm 10W			
50K Ohm 50W			
200K Ohm 25W			
Capacitors	±5%	Load	
200 pf 1500V			
500 pf 500V	±5%	Load	

Push the Volts, Volts/Milliamperes 1000 and -DC buttons and arrange the multimeter to read -1000 volts DC. Press the Operate button and observe that the meter reads approximately -1000 volts DC.

Push the X10 Hertz button and set 40 on the Frequency dials, observe that the Calibrator is in Standby. Arrange the multimeter to read 1000 volts AC. Press the Operate control and observe that the multimeter reads approximately 1000 volts.

Check the operation of the Volts/Milliampere 100 and the Millivolt/Microampere 1000 ranges in a manner identical to that which was used to check the 1000 volt range at 400Hz, in each case observing the meter reading, and that the Calibrator automatically is placed in Standby upon switching function, range or frequency.

Set the Calibrator to +DC Volts on the 10 volt range and the setting to 5.000. Set the multimeter to read 5 volts DC. Press the Operate control. Press the Deviation 10% full scale button. Rotate the Deviation control from + to - observing that the multimeter reading varies from 4.5 to 5.5 volts.

Observe that the decimal indicators correctly indicate decimal location for each selection of function and range.

Observe that the units indicators show the correct units for the appropriate selection of function and range.

Observe that the AC indicator shows the selection of any AC mode and the ohms indicator shows the selection of the ohms function.

Observe that the use 750 indicator shows the selection of the function 10 AMPS.

Observe that the Setting Error shows the selection of "0" Setting MSD in any AC mode.

Observe that the 10 ohm output Z indicator shows the selection of 100 or 10 millivolt ranges.

Observe that the high voltage indicator is illuminated for AC or DC voltages in excess of 10 volts.

4.3.2 DC Voltage Accuracy, Less Than 10 Volts

Arrange the Precision Calibrator and the test equipment as shown in Figure 4-2. Set the Model 710 to +DC 10 Volts with a setting of X.000, and the Deviation selector in the Off position. Start with this setting and, using the output of the Decade Divider at each point as a reference, check each setting in sequence on the performance check list of Table 4.2 under DC Voltage Accuracy for all DC voltages less than 10 volts.

4.3.3 DC Voltage Accuracy Tests Greater Than 10 Volts

Precision
Calibrator
Rotek Model 710

Multimeter
Weston Instruments Inc.
Model 6000

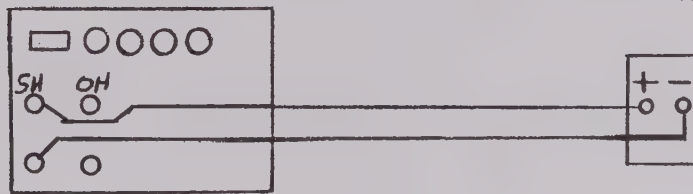


Figure 4-1

Function Check

Precision
Calibrator
Rotek Model 710

Nullmeter
Keithley 155

Decade Divider
Fluke 720A

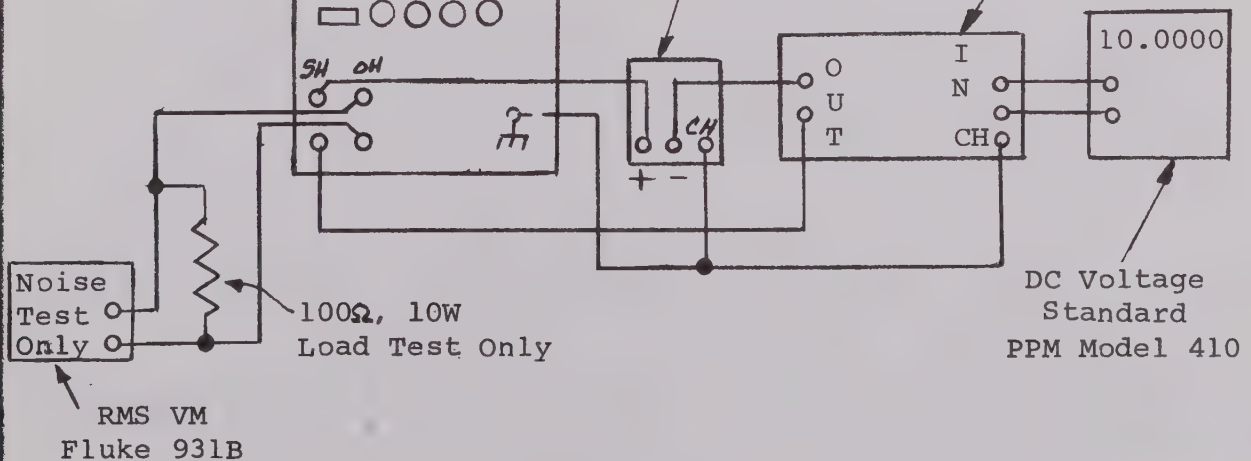


Figure 4-2

DC Voltage Less Than 10 Volts

Accuracy Test

Arrange the test equipment as shown in Figure 4-3; connect the point "A" to the 500000 ohm point on the Volt Ohm Box. Select the setting +X0.00 DC volts on the Model 710 and set the Decade Divider to the reference setting of 10 volts.

Prior to setting +X00.0 volts on the Model 710 attach point "A" to the 5 Mohm terminal on the Volt Ohm Box, ESI Model 1063.

4.3.4 DC Loading

Using the equipment arranged in the configuration of Figure 4-3 set the Model 710 to +X00.0 volts and, prior to pushing the Operate button, connect a 200 Kohm $\pm 5\%$, 25 watt resistor across the output terminals.

Arrange the equipment in the configuration of 4-2 to determine the effect of loading at the setting X.000 volts, connect a 100 ohm $\pm 5\%$, 10 watt resistor across the output terminals. Measure the output voltage.

Notice in each of the figures the load is attached to the Output High and Output Low terminal pair, but the voltage measurement is made at the Sense High and Sense Low terminal pair.

4.3.5 Noise Test

Arrange the equipment in the configuration of Figure 4-3 and set the Calibrator to read 100.0 volts, attach the RMS Volt Meter, Fluke Model 931B, to the Sense terminals and measure the noise output in the operate condition at that setting.

Arrange the equipment in the configuration of Figure 4-2 attaching the RMS reading voltmeter, Fluke Model 931B, and measure the noise appearing at the output at a setting of X.000 volts.

4.3.6 Deviation Test

Arrange the equipment as shown in Figure 4-2, setting the Model 710 to 5.000 volts DC, set the Deviation scale button to 10%, and set the Decade Divider, John Fluke 720A, to .5500000 use the Deviation Dial to achieve a balance on the Kiethley Null Meter. The Deviation at null is between the limits -9.8 and -10.2.

Set the Decade Divider to .4500000 and use the Deviation control to achieve a balance on the Null Meter. The Deviation is between the limits -9.8 and -10.2.

Set the Decade Divider to .5050000; push the 1% full scale Deviation button and cause a balance on the Null Meter. Record the Deviation.

Set the Decade Divider to .5005000; push the 0.1% Deviation button and use the Deviation control to achieve a balance on the Null Meter. Record the Deviation.

4.3.7 AC Voltage Accuracy Tests

Arrange the apparatus as shown in Figure 4-4, place the Calibrator and the Thermal Voltmeter in the Standby mode. First set the Model 710 at the voltage setting to be calibrated in the DC volts mode. For example the first point to be tested is the X00.0 setting at 50 Hertz; set the Model 710 +DC volts, X00.0. In this series of tests the DC reference for the Thermal Transfer Voltmeter will be the previously tested settings of the Precision Calibrator Model 710. Apply the DC output of the Calibrator to the Thermal Transfer Voltmeter on the proper scale and balance the Voltmeter. Place the Thermal Transfer Voltmeter in standby and transfer the Calibrator from DC to AC operation at the measurement frequency (ie. 50Hz for the first test point). Apply the output of the Model 710 to the Thermal Transfer Voltmeter, leaving the amplitude setting unchanged, and observe the error in % on the Transfer Voltmeter indicator directly.

The capacitive loading of the Transfer Voltmeter may cause a measureable deviation from the no load Model 710 output at higher frequencies. If the no load output voltage needs to be measured, connect the RMS Voltmeter, Fluke 931B, to the output during the preceeding measurement. Set the Model 931B in the diffferential mode and balance the Model 931B at the output setting. Observe the deviation on the Fluke Model 931B Voltmeter when the Thermal Transfer Voltmeter is removed, by placing it in standby. Take due regard to sign, add the deviation on the Fluke Voltmeter to the previously determined deviation on the Holt Thermal Transfer Voltmeter to compute a new deviation which is the deviation at no load. This measurement is repeated for each setting listed under the AC voltage accuracy tests.

4.3.8 AC Loading

This test involves a two step procedure. The first step calibrates the RMS Voltmeter, Fluke Model 931B, using the Precision Calibrator Model 710 and the Holt Model 6A; the second step uses the Fluke Model 931B to measure the deviation from the standardized value with load.

Set the Model 710 to the equivalent DC voltage of the test point. With no load attached to the output terminals balance the Holt Model 6A Thermal Transfer Voltmeter. Observing precautions in the transfer, change to AC operation of Model 710. Apply the output of 710 to the Holt Model 6A, and using the appropriate deviation range of the Model 710 balance the Holt Model 6A. The output of the Calibrator is now standardized, and the Fluke RMS Voltmeter is connected to the output of of the Calibrator and adjusted to a null in the diffferential mode condition on the most sensitive scale. The Model 931B is now also standardized. Disconnect the Holt Model 6A and attach the load described on the check list to the output of the calibrator (making sure the Calibrator is in the standby mode when the load is connected), press the Deviation OFF button. Operate the Calibrator and observe the deviation on the Fluke Voltmeter recording the deviation in percent.

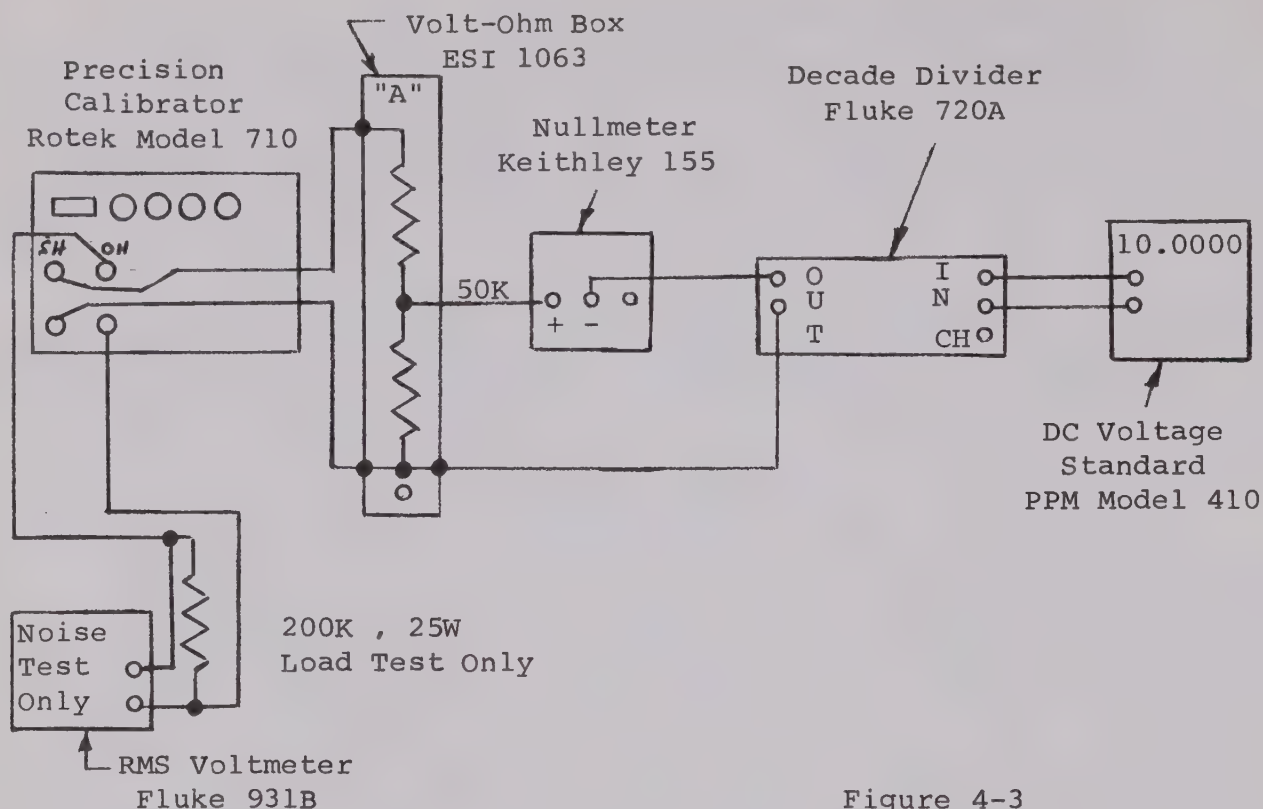


Figure 4-3

DC Voltage Greater Than
10 Volts. Accuracy Test

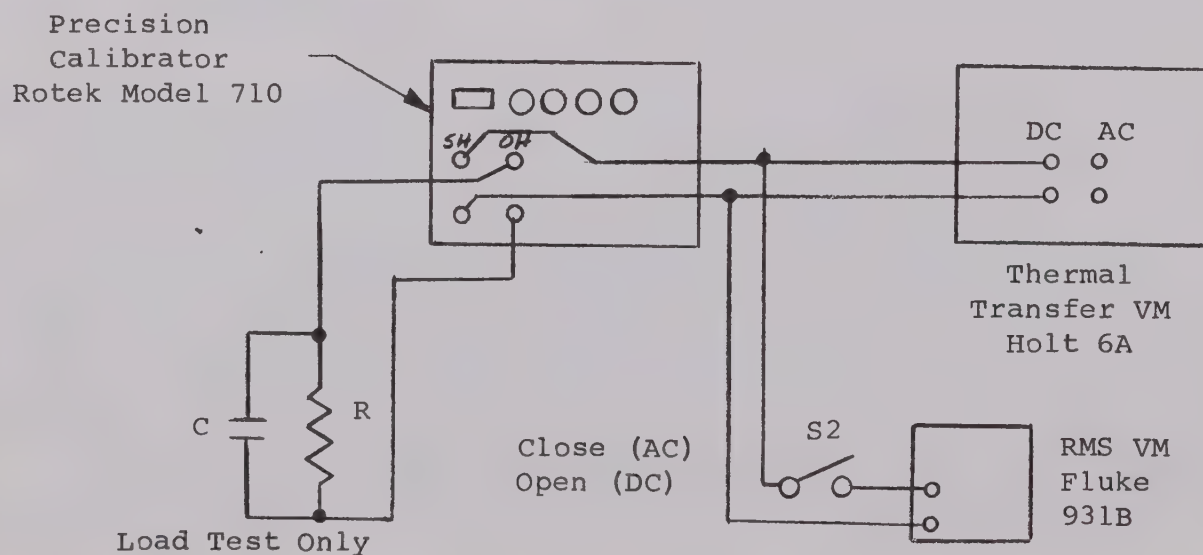


Figure 4-4

AC Voltage. Accuracy Test

Repeat these measurements for each load and setting in the check list.

4.3.9 AC Noise and Distortion Tests

Connect the equipment as shown in Figure 4-5. To measure the distortion at a setting of 50Hz and X00.0 volt an attenuator is required between the Calibrator and the Distortion Analyzer. This attenuator is not necessary at any of the other points. The distortion may be measured directly in percent on the Distortion Analyzer. In some locales where strong radio interference is present the Distortion Analyzer may detect this interference and indicate erroneous readings. Should this be the case, it may be necessary to attach a wave filter tuned to the frequency of the interfering broadcast station at the input terminals of the Distortion Analyzer to eliminate the harmful effects.

4.3.10 DC Current Tests

Arrange the equipment as shown in Figure 4-6 to perform the tests at X00.0 milliamperes. Use the 0.1 ohm Leeds & Northrup Model 4221-B Current Shunt. Set the Model 710 to the X00.0 milliamper DC setting. Adjust the Decade Divider to 0.0100000. Operate the Calibrator and observe the deflection on the Keithley Null Meter.

To conduct the current accuracy test at 2.0 volt compliance and X00.0 milliamperes add the 1.9 ohm resistor as shown in Figure 4-6. Repeat the measurement of the preceeding paragraph.

Reduce the setting of the Model 710 to 100.0 milliamperes, remove the 0.1 ohm shunt and replace it with a 10 ohm shunt, ESI Model 1063. Remove the 1.9 ohm resistor and replace it by a short in the following tests. Set the Decade Divider, ESI RV722, to 0.1000000. Operate the Calibrator and observe the deflection the the null meter. Repeat this test for a setting of -X00.0 DC milliamperes.

Repeat the measurement of the preceeding paragraph setting the Model 710 to X0.00 milliamperes and using a 10 ohm shunt.

Repeat the preceeding measurements using a setting of X.000 milliamperes and a 100 ohm shunt.

Repeat the measurements of the preceeding paragraph with a setting of X00.0 microamps employing a 1000 ohm shunt.

Repeat the measurement of the preceeding paragraph at a setting of X0.00 microamps using a 10000 ohm shunt and setting the voltage divider at 0.10000000.

Repeat the preceeding measurement at a setting of X.000 microamps using a 100000 ohm shunt.

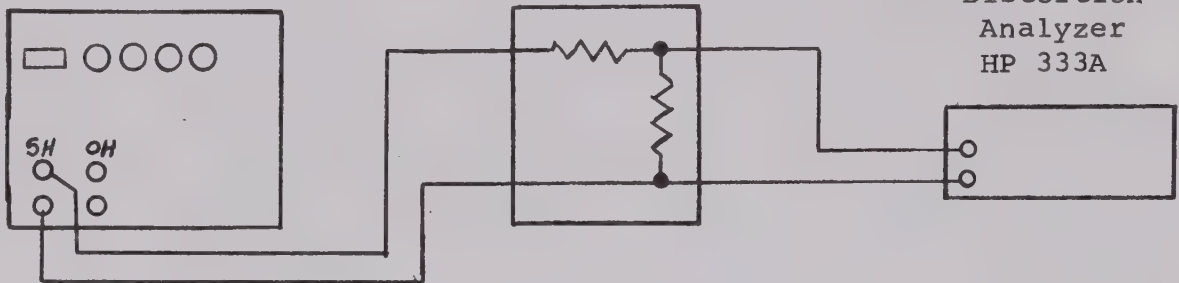
4.3.11 AC Current Tests

The AC current is tested by calibrating first the drop in a

Precision Calibrator
Rotek Model 710

10:1
Attenuator

Distortion
Analyzer
HP 333A



AC Noise and Distortion Test

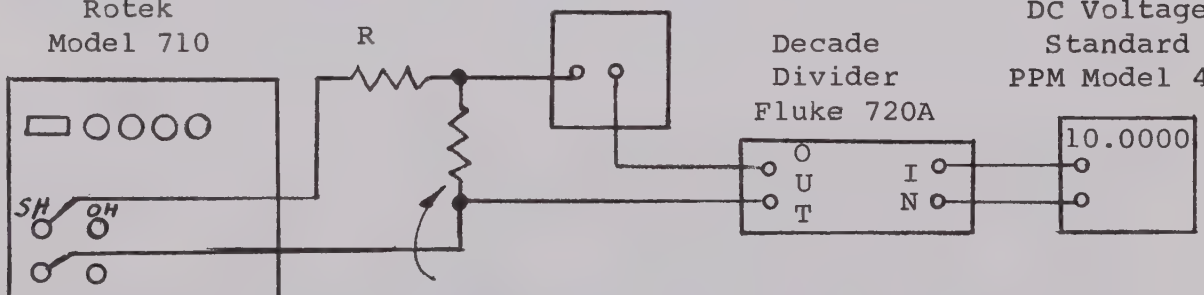
Figure 4-5

Precision
Calibrator
Rotek
Model 710

Nullmeter
Keithley 155

Decade
Divider
Fluke 720A

DC Voltage
Standard
PPM Model 410



Current Shunt
for 0.1 Ω , L&N 4221B
5 Ω , ESI 1063

Value of R, 1.9 Ω , 10W
Use only at X00.0mA

DC Current. Accuracy Test

Figure 4-6

Precision
Calibrator
Rotek
Model 710

Thermal
Transfer VM
Holt 6A

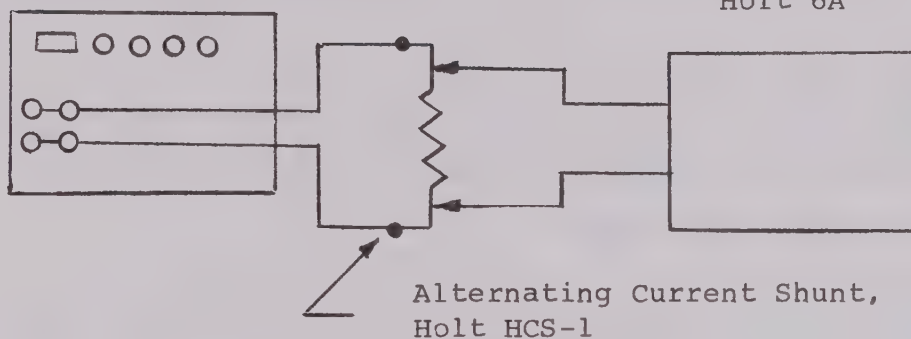


Figure 4-7

AC Current Accuracy Test

Precision
Calibrator
Rotek
Model 710

John Fluke Company
Model 931B Voltmeter

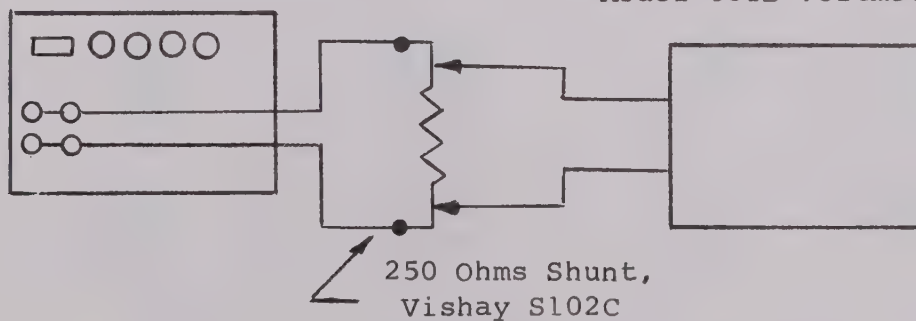


Figure 4-8

AC Current Accuracy Test 1000 Microamps.

precision shunt caused by a DC current at the standard value, and comparing this drop with the drop caused by the corresponding AC current. Arrange the equipment as shown in Figure 4-7. Use a 1 ampere shunt and set the Model 710 to X00.0 milliamperes DC. Balance the Holt Model 6A Thermal Transfer Voltmeter observing the usual precautions. Change the Model 710 to 400Hz operation at the same current setting and observe the deviation on the Model 6A deviation meter, reading it directly in percent.

Change the current shunt to a 100 milliampere shunt and repeat the measurements above for settings of 100.0 milliamperes at the test frequencies.

To verify the performance at 1000 microamperes the test circuit of Figure 4-8 is used. The shunt is a Vishay Resistance Product Company 250 ohm S102 resistor. Readings of the Fluke Model 931B should be increased by +.025% to account for meter loading.

4.3.12 Resistance Mode Tests

Arrange the Model 710 as described in paragraph 2.7 in the four wire resistance (for settings 1 to 1000 ohm) configuration and connect it in the circuit of Figure 4-9. For settings greater than 1000 ohms arrange the Model 710 in the two wire configuration.

Use a substitution method to measure the resistance. First connect the Resistance Standard to the circuit and **disconnect** the Rotek Model 710. Apply the current (as given in the table below) to the Standard and adjust the Decade Divider to obtain a null. Now disconnect the Resistance Standard and connect the Rotek Model 710. Without changing the setting of the current source, measure the deviation of the Null Meter. The deviation in microvolts corresponds to a percent error as given in the table below. To establish confidence repeat the measurements.

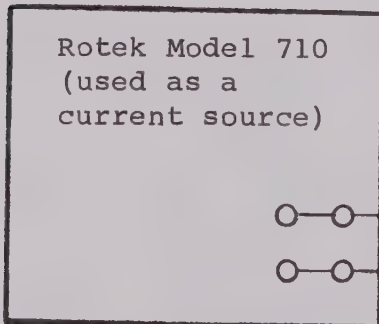
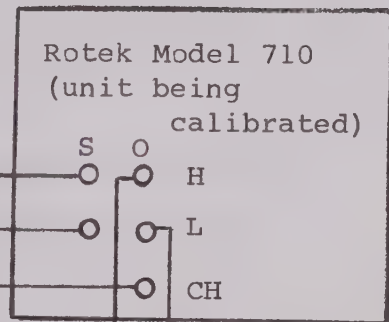
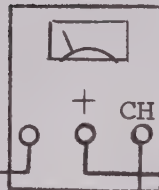
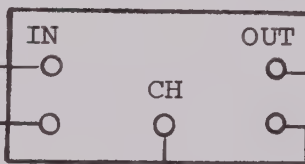
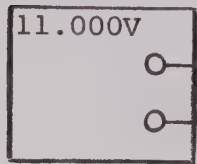
	Model 710 Setting (Ohms)	Standard Resistance Value	Stable Current Value	Null Meter Sensitivity
4 Wire	1	1	100mA	10uV = 0.01%
	10	10	50mA	50uV = 0.005%
	100	100	10mA	50uV = 0.005%
	1K	1K	1mA	50uV = 0.005%
2 Wire	10K	10K	200uA	100uV = 0.005%
	100K	100K	20uA	100uV = 0.005%
	1M	1M	2uA	100uV = 0.005%
	10M	10M	0.2uA	1.0mV = 0.05%

Table for Resistance Measurements

Nullmeter
Keithley Model 155

DC Voltage
Standard PPM
Model 410

Decade Divider
Fluke Model 720A



Resistance
Standards
L & N
4020B
4025B
4030B

ESI Volt Ohm Box
Model 1063
(Use Two Wire
Connection
> 1000Ω)

Resistance Measurement

Figure 4-9

4.4 Calibration Procedure

Table 4-3 is a list of the steps required to calibrate the Series 710. All measurements are made at the Sense High and Sense Low terminals. The temperature is $23^{\circ}\text{C} \pm 1^{\circ}\text{C}$. All adjustments are made with the Calibrator in the Operate Condition and the Deviation off, unless otherwise specified in the table. The calibration is performed at the nominal line voltage $\pm 1\%$, 50-60 Hertz with the top cover of the instrument and the inner Guard cover in place. The top cover is momentarily slid to the rear to make any required adjustments or measurements. Adjustments are identified on the Guard cover, inside the top cover. Use caution in making connections to the test points underneath the Guard cover as the Guard cover is at ground potential. Accidental shorting between test points and Guard or between the Guard and internal circuitry on the modular plug-in assemblies could destroy components.

4.5 Periodic Maintenance

The following procedures are recommended.

4.5.1 Air Filter

The cooling fan installed in the Series 710 Calibrator is fitted with a washable filter, which may be removed for cleaning by removing the four domed nuts holding the finger guard in place on the rear panel.

It is important that this filter is cleaned by washing or blowing out with an air line, regularly. The exact interval depends on the environment in which the instrument is operated, but once a month is recommended where use is outside "Clean" areas.

Neglect of this operation will lead to dust being circulated inside the instrument or a blocked filter, both conditions with possible adverse effects on reliability.

4.5.2 Degreasing

Leakage across the surface of some of the sensitive analog circuits can introduce intermittent varying errors. All such circuits are protected by guard paths. However, sufficient leakage can be introduced by the residue from handling the modules.

If a repair involving soldering is required, or if the modules are handled for any reason, the modules should be cleaned by washing with pure grain alcohol applied with a clean brush. Trichlorethelene may also be used if alcohol is not available.

Do not submerge the modules in these solutions as some of the electronic components may be damaged thereby.

Table 4-2
Series 710
Performance Check List

Function	Observed Setting	Reading	Allowable Limits *
Front panel controls:			
Power On-Standby Check		-----	
Operate on Check		-----	
Standby on Check		-----	
Volts, Amps, 10 Amps		-----	
Ohms		-----	
Ranges		-----	
DC, Frequency		-----	
Deviation		-----	
Decimal Indicators		-----	
Units Indicators		-----	
DC Voltage Accuracy			
+10 Volt Range	X.0000V	-----	220uV
	9.9999V	-----	220uV
	8.8888V	-----	198uV
	7.7777V	-----	176uV
	6.6666V	-----	153uV
	5.5555V	-----	131uV
	4.4444V	-----	109uV
	3.3333V	-----	87uV
	2.2222V	-----	64uV
	1.1111V	-----	42uV
	1.0000V	-----	40uV
-10 Volt Range	-X.0000V	-----	220uV
	-1.0000V	-----	40uV
+1000 mVolt Range	X00.00mV	-----	27uV
	100.00mV	-----	9uV
-1000 mVolt Range	-X00.00mV	-----	27uV
+100 mVolt Range	X0.000mV	-----	4.5uV
+10 mVolt Range	X.0000mV	-----	2.2uV
+100 Volt Range	X0.000V	-----	220uV
+1000 Volt Range	X00.00V	-----	320uV
-1000 Volt Range	-X00.00V	-----	320uV
DC Loading			
5mA (200K ohms, 25W)	X00.00V	-----	320uV
100mA (100 ohms, 10W)	X.0000V	-----	220uV
DC Noise:			
10mA Load	100.00V	-----	50mV/RMS
No Load	9.X000V	-----	5mV/RMS

* Limits on observed readings in test circuit

Table 4-2 (cont.)

Performance Check list

Function	Setting	Observed Reading	Allowable Limits *
Deviation Control:			
10% Full Scale	+10.0	-----	9.8 - 10.2
10% Full Scale	-10.0	-----	9.8 - 10.2
1% Full Scale	+1.00	-----	.98 - 1.02
.1% Full Scale	+.100	-----	.098 - .102

After these tests be sure to press the DEV OFF button.

AC Voltage Accuracy:

1000 Volt Range	50Hz	X00.00V	-----	.055%
	400Hz	X00.00V	-----	.0275%
	10000Hz	X00.00V	-----	.055%
	20000Hz	500.00V	-----	.088%
	50Hz	100.00V	-----	.1%
	400Hz	100.00V	-----	.05%
	20000Hz	100.00V	-----	.16%
100 Volt Range	50Hz	X0.000V	-----	.055%
	20000Hz	X0.000V	-----	.055%
	50000Hz	X0.000V	-----	.088%
10 Volt Range	400Hz	X.0000V	-----	.0275%
	20000Hz	X.0000V	-----	.055%
	50000Hz	X.0000V	-----	.088%
1000 mVolt Range	400Hz	X00.00mV	-----	.0275%

AC Loading:

20mA (50K, 50W)				
and 150pf	400Hz	X00.00V	-----	.055%
150pf	10000Hz	X00.00V	-----	.085%
50mA (200 ohms, 10W)				
and 500pf	400Hz	X.0000V	-----	.055%

DC Current Accuracy:

1000mA +2.0 V Compliance		X00.00mA	-----	.025%
-2.0 V Compliance		X00.00mA	-----	.025%
1.0 V Compliance		100.00mA	-----	.04%
100mA	"	X0.000mA	-----	.022%
10mA	"	X.0000mA	-----	.025%
1000uA 1.0V Compliance		X00.00uA	-----	.027%
100uA	"	X0.000uA	-----	.072%
10uA	"	X.0000uA	-----	.52%

AC Current Accuracy:

1000mA				
1.0V Compliance	400Hz	X00.00mA	-----	.055%
100mA				
.25V Compliance	400Hz	100.00mA	-----	.1%

Table 4-2 (cont.)

Performance Check List

Function	Setting	Observed Reading	Allowable Limits
1000mA			
.25V Compliance	400Hz X00.00mA	-----	.55%
	5000Hz X00.00mA	-----	.25%
	10000Hz X00.00mA	-----	.5%
	20000Hz X00.00mA	-----	1.5%
Resistance Accuracy:			
4 wire connections.	1 ohm		.0002 Ohms
	10 ohms	-----	.002 "
	100 ohms	-----	.005 "
	1000 ohms	-----	.05 "
	10K ohms	-----	.5 "
	100K ohms	-----	5 "
	1M ohm	-----	50 "
	10M ohms	-----	5000 "

Table 4-3

Model 710

Calibration Procedure

NOTE: Be sure deviation is in off mode before calibration.

NOTE: Unless otherwise specified REF GND is in the sense low terminal.

1.0 Turn on Power, set to +10 VDC, 0.000, Operate and allow to warm up for at least 8 hours. Adjust PA Idle Current (R133 on PA) to .15A. (Adjusted at factory, do not readjust except after repair of power amplifier.)

1.1 Oscillator Adjustments (Do not readjust factory adjustment except after a repair.)

1.1.1 AR5 Balance Adjust (Factory Adjustment)

Set 10.000V, 40Hz, Operate: observe on an oscilloscope (AC coupled) the signal at TP5 OSC/ATT Module. Minimize the signal by adjusting R54. Refer also to P. 4.3.9 procedure.

2.0 Reference Trim Resistors/Reference Adjustment.

2.1 Measure the dc Zener Voltage (V_z) at the AC Control/Reference - TP5. Select the values of resistors from the relation.

$$R = V_z \quad (1001.25) \text{ Ohms, and install the same.}$$

(This is a factory adjustment, not required for periodic recalibration.)

2.2 Measure the dc Reference voltage at the AC Control/Reference TP6 and adjust it using R102 to -8.000000 $\pm 10\mu\text{V}$ with the setting as in step 1.0. Refer to P. 4.3.2 procedure.

3.0 Adjustment of Precision Amplifiers.

3.1 Main Summing Amplifier.

Measure the voltage at the Sense High Terminal. Set to +1000mV DC, 000.0, Operate. Adjust R50 for zero $\pm 10\mu\text{V}$ DC. Set to 10 VDC, 000.0 Operate. Adjust R57 for zero $\pm 10\mu\text{V}$ DC. Repeat alternately for zero +5uV DC in both settings. (After completion set ± 10 VDC,

3.2 Inverting Amplifier (Main Summing Amplifier/PA)
Set to -10 VDC, 0.000, Operate. Measure voltage at Sense High Terminal. Adjust R27 for zero $\pm 10\mu\text{V}$ DC.

4.0 Adjustment of Precision Attenuator (OSC/ATT)
Set +10 VDC, 0.000, Operate; measure the voltage at the Sense

High terminal. It should be $0 \pm 5\mu\text{V}$. If it is not repeat step 3.2 Set $-10\text{ VDC } 0.000$, Operate; the voltage should be $0 \pm 5\mu\text{V}$; a minor adjustment of R27 Main Summing Amplifier/PA may be required. Refer to P. 4.3.2 procedure.

- 4.1 Set $+10\text{ VDC}, 8.000$, Operate; adjust R73 of the OSC/ATT to obtain $8.000000 \pm 25\mu\text{V}$.
- 4.2 Set $+10\text{ VDC}, 4.000$, Operate; adjust R72 to obtain $4.000000 \pm 25\mu\text{V}$.
- 4.3 -4.8 Obtain $2.000, 1.000, 0.800, 0.400, 0.200$ and 0.100 in turn by adjusting respectively R71 through R66.
- 4.4 Set $+10\text{VDC}$, the 3rd decade "x" Adjust R125 to obtain $0.1000 \pm 10\mu\text{V}$.
- 5.0 Adjustment -10.000 Volts DC
Set $-10\text{ VDC}, -X.000$, Operate. Adjust R24 of Inverting Amplifier on Main Summing Amplifier/PA to obtain $-10.00000 \pm 30\mu\text{V}$ at Sense High terminal.
- 6.0 Adjustment $+1000\text{mV DC}$
Set $+1000\text{mV DC}, X00.0$, Operate. Adjust R17 of Output Sense to obtain $1000\text{mV} \pm 10\mu\text{V}$ at the Sense High terminal. Check $-X00.0\text{mV}$. It may be necessary to readjust R17 to get best balance.
- 7.0 $100\text{ Millivolts DC Adjustment}$
Set to $+100\text{mV DC}, X0.00$, Operate. Adjust R30 of Output Sense to obtain $0.100000 \pm 2\mu\text{V}$ at the Sense High.
- 7.1 $10\text{ Millivolts DC Adjustment}$
Set to $+10\text{mV DC}, X.000$, Operate. Adjust R32 of Output Sense to obtain $0.010000 \pm 2\mu\text{V}$ at the Sense High.
- 8.0 $100\text{ Volts DC Adjustment}$
Set $+100\text{V}, X0.00$, Operate. Adjust R12 of Output Sense to obtain $+100.00 \pm 100\mu\text{V}$ at the Sense High terminal. Check -100V . Readjust R12 for best balance if necessary.
- 9.0 $1000\text{V DC Adjustment}$
Set $+1000\text{V DC}, X00.0$, Operate, adjust R6 of Output Sense to obtain $+1000.000 \pm 1\text{mV}$ at the Sense High terminal. Check -1000V DC and readjust R6 for the best compromise location.
- 10.0 $400\text{Hz}, 10\text{V Adjustment}$
Set $\text{Hz} \times 10, 40, 10\text{V}, X.000$, Operate; adjust R42 of the AC Control/Reference to obtain $10.0000\text{ volts} \pm 0.01\%$ at the Sense High terminal. Refer to P. 4.3.7 procedure.
- 10.1 At $\text{Hz} \times 1000, 10\text{V}$, vary frequency 10kHz to 100kHz . Adjust C2 to be less than $\pm 10\%$ (Output sense board). 1000mV trim is C1 (typical trim value 33pF), on Output Sense board. Increasing capacitance reduces output.

- 11.0 100KHz, 100V Adjustment
Set kHz, X0, 100V, X0.00, Operate; adjust C15 of Output Sense to obtain 100.00 $\pm 0.005\%$ at the Sense High terminal. Vary frequency from 5kHz to 100kHz and adjust for optimum.
- 12.0 10kHz, 1000V Adjustment
Set kHz, X0, 1000V, X00.0, Operate; adjust C7 of Output Sense to obtain 1000.00 $\pm 0.005\%$ at the Sense High Terminal. Vary frequency up to 20kHz. If necessary, readjust C7 for best balance between 1000V, 10Hz and 500V, 20kHz.
- 13.0 DC Current (Refer to P. 4.3.2 procedure)
- 13.1 Set +100mA, 00.00, Operate. Connect a 100 ohm $\pm 0.001\%$ shunt between Sense High and Low terminals. Measure across shunt with test set-up at zero. Adjust R77 on MSA/PA board to zero $\pm 10\mu\text{V}$. Leave shunt in place.
- 13.2 Set +1000uA, X00.0, Operate. Adjust R65 for .1V $\pm 5\mu\text{V}$ across the shunt.
- 13.3 Set +1000mA, X00.0, Operate. Measure current through a 1 ohm $\pm 0.001\%$ shunt, adjusting R110 to obtain 1000mA $\pm 20\mu\text{A}$.
- 13.4 Set +100mA, X0.00, Operate. Measure current through a 10 ohm $\pm 0.001\%$ shunt, adjusting R108 to obtain 100mA $\pm 10\mu\text{A}$.
- 13.5 Set +10mA, X.000, Operate. Measure current through a 100 ohm $\pm 0.001\%$ shunt, adjusting R104 to obtain 10mA $\pm 10\mu\text{A}$. Leave shunt in place.
- 13.6 Set +100mA. 10mA, Operate. Measure current through the 100 ohm shunt, adjusting R72 for 1V $\pm 200\mu\text{V}$.
- 13.7 Set -100mA, -10mA, Operate, same shunt. Readjust R72 to get best balance between + and -, steps 13.6 and 13.7. Then adjust R77 to get zero $\pm 50\mu\text{A}$.
- 13.8 Repeat 13.2 through 13.5, checking both plus and minus, re-adjusting where necessary to best compromise.
- 14.0 AC Current Adjustment
- 14.1 Set 1000mA, 40Hz, X00.0, Operate, and measure the current from the Sense High to the Sense Low terminals adjusting it to 1000.0mA $\pm 0.005\%$ via R30 on the AC Control/Reference module. Refer to P. 4.3.11 procedure.
- 15.0 High Frequency Current Adjustment
- 15.1 Check 100mA, 1V compliance, generally highest point, and 10mA (bottom of 100mV range) at 0.25V compliance, generally lowest point, at 20kHz. The average of these two points will be high. Add capacitance to C29 on MSA/PA board (typical value 47pf) to get best balance, favoring 1000mA.

- 15.2 At 20kHz, check all ranges full scale at 1V compliance and bottom of ranges at 0.25V compliance at 20kHz. Spec is 1%.
- 15.3 100uA, bottom of 1000uA range, may be low. To bring it up add capacitance to C39 on MSA/PA board. This trim effects the 100uA range only. Typical value 22pf.
- 16.0 Error Meter Adjustment (Refer to P. 4.3.2 procedure)
Set 710 to 5.0000V DC, Operate. Adjust the decade divider for 50000. Push deviation X.1% button and adjust deviation control so output is again 5.0000V. Meter should read zero, (.000). Change divider to read 500500. Adjust deviation control to get null on null meter. Meter should read -0.100. Adjust pot on front pc board near meter if necessary. Change divider to 499500 and adjust deviation control to get null. Meter should read 0.100. It may be necessary to readjust the pot to get the best balance, ± 0.002 . Change divider to 495000 then 450000, checking X1% and X10% deviation ranges. It may be necessary to adjust pot to get best compromise.
- 17.0 Ohms adjustment (Refer to P. 4.3.12 procedure)
To adjust 1 ohm, put 100mA through the standard 1 ohm and measure resulting voltage with test set-up. Adjust current source to get 100.000mV. Transfer 710 source leads to "OUT" terminals, and set-up to "SENSE" terminals. Adjust 1 ohm pot (on Control Logic board) to 1.00000 ohm. Keep cover of UUT closed as much as possible. Transfer leads back to standard resistor to check that source hasn't shifted.

NOTE: When transferring leads, short the output of the source so that it will always remain in Operate.

Adjust 10 ohms and 100 ohms in a similar manner, using the 10 and 100 ohm standard shunts, and using 100 and 10mA as the current source. Set up the source to read 1.00000V across the resistor under test. Re-check source after each measurement as was done at 1 ohm.

TABLE 4-4
MODEL 710 MALFUNCTION CHART

MALFUNCTIONS	PARAGRAPH
Physical (Parts loose, etc.)	4.6.1
Common Failures	
Application of External Voltages	4.6.2.1
Relay Arcing	4.6.2.2
Relay Driver Failure	4.6.2.3
Unstable 1000mV DC Readings	4.6.2.4
Power Supply Chart	4.6.3
LED Display Defective	4.6.4
Standby/Operate Malfunction	4.6.5
General Troubleshooting	4.6.6
Fault in DC Volts Less Than 10 Volts	4.6.6.2
Fault in AC Voltage	4.6.6.3
Fault in DC Volts Greater Than 10 Volts	4.6.6.4
DC Current Malfunction	4.6.6.5
AC Current Malfunction	4.7

4.6 Troubleshooting in Case of Malfunction

WARNING

MODEL 710 PRODUCE HIGH VOLTAGE WHICH CAN CAUSE SHOCK. CARE MUST BE EXERCISED IN HANDLING ONCE THE COVERS ARE REMOVED FOR SERVICE. ONLY QUALIFIED PERSONNEL SHOULD ATTEMPT TO SERVICE THIS EQUIPMENT.

4.6.1 Physical Examination

In the event of a malfunction disconnect the power line cord and disassemble as follows:

1. Remove to cover affixed by two screws at the rear.
2. Remove cross strut over top guard cover affixed by two screws into side extrusion.
3. Disconnect connectors on Multiplexer Assembly Pl7, 18, 19 and 20.
4. Remove top guard cover affixed by eight screws into the front and rear guard panels.
5. Remove spacer bar fastened by two flat head screws into front and rear guard panels.

Examine the interior of the Calibrator for loose or broken parts particularly:

1. Modular PC cards not in receptacles or not seated properly.
2. Relays loose, bails not affixed properly.
3. Transistors or integrated circuits not in sockets.

Replace all loose parts and observe performance to see if the malfunction has been corrected. Do not replace covers, etc. until assured of performance, as further work may be necessary.

4.6.2 Some Commonly encountered Failures

4.6.2.1 Application of External High Voltages (usually the line voltage) to Output Terminals of Calibrator.

The result is usually a failure to Operate in any mode. This usually destroys the small signal transistors in the power amplifier (see 07-119-001, 3/3 page 6-29) Q1 and Q2.

Quite often in this failure mode one or more of the IC relay drivers on the Control Logic Module fail. Check relay function per Table 3-1. Locate relay drivers on the Control Logic Schematic 07-113-001 pages 6-17 and 18 with the symbol . Check all power supplies (see below).

4.6.2.2 Relay Breakdown (Arcing)

This failure results in transitions to standby whenever high voltages are called for. Sometimes the functions will change without apparent reason or more than one function indicator will be illuminated at the same time (i.e. the current indicator will be illuminated when the voltage button is depressed or both the voltage and the current indicators will be illuminated). Frequently the arcing of a relay can be heard, and in the dark seen, if the covers are all removed. This usually occurs in relay K15 of the Output Sense (see 07-121-001, page 6-31). Replace all arcing relays with American Zettler AZ421-70-220 only.

CAUTION.

When operating at high voltages in the dark do not come in contact with the calibrator.

4.6.2.3 Relay Driver Failure

This may result in transitions to standby although all indicators function normally. The operation of the relays may be visually checked by looking for intermittents by switching the relays on and off several times.

4.6.2.4 Relay Contact Resistance Increases - 1000mV Range

This is most noticeable on the 1000mV range and is caused by faulty performance of K4 on the Output Sense module. It usually results in erratic output; changes of 1 to 2 mV may be observed. Clean relay K4. Sometimes the resistance is between the relay socket and the contacts on the relay base which could be cleaned with a mild abrasive.

Erratic operation in the current mode can be caused by poor relay contact in relays K5, 6, 7, 8 and 9 (07-119-001, 2/3 page 6-28) which should be cleaned or replaced.

Relays K1, 2 and 3 of the same circuit can cause sudden 0.01% shifts for VDC >10 or -VDC any range. When in doubt, remove the potentially faulty relay and substitute. Clean or replace the faulty relay.

4.6.3 Power Supply Chart

As a rule it is a good idea to check all power supply voltages when a failure occurs. The table below lists the power supplies and a normal voltage range; when a fuse is in the circuit make sure that it is continuous. Refer to schematic 07-000-001, 1/2 page 6-6.

Supply Voltages	Limits	Location	Fuse Designation
+33V	32 to 40V	J1-6, 61, 62	Check F1
-33V	32 to 40V	J1-6, 59, 60	Check F2
+15V	±.25V	J1-6, 43, 44	

-15V	+.25V	J1-6, 47, 48	
+1.8V	+.15V	J1-6, 55, 56	
-12.6V	+.15V	J1-6, 57, 58	
+24V	+5V	J1-6, 53, 54	
+5V	+.25V	J1-6, 49, 50	Check F3
+5V	+.25V	07-105-000	
		AR1, Pin 2 (rear panel)	

4.6.4 Defective Displays

If no display at all and no power light, check line fuses located in Corcum line connector on rear panel. If no display at all but power light is illuminated:

1. Thermal cutout switch S32 on 07-000-001, 1/2 is open due to possible overheat (very rare if adequate circulation has been provided) or defective switch. **USE CAUTION** as line voltage is applied to S32. Defective switch is very likely. Occassionally for high line voltages, switch opens. Replace with higher temperature rated switch.
2. F3 is blown. Determine cause and repair.

If any individual LED fails to be illuminated or is illuminated greater than normal, check starting with the LED driver circuitry (see 07-111-001, 2/4). Work backwards from LED to find logical inconsistency. Logical assertion is the LOW state.

SELECTION OF SWITCHES

LEDS ILLUMINATED

Volts, +DC, 1000V	Volts, Right Decimal, HI VOLT
Volts, +DC, 100V	Volts, Center Decimal, HI VOLTS
Volts, +DC, 10V	Volts, Left Decimal
Volts, +DC, 1000mV	mVolts, Right Decimal
Volts, +DC, 100mV	mVolts, Center Decimal, 10 ohms Z
Volts, +DC, 10mV	mVolts, Left Decimal, 10 ohms Z
Amps, +DC, 1000mA	Milliamps, Right Decimal
Amps, +DC, 100mA	Milliamps, Center Decimal
Amps, +DC, 10mA	Milliamps, Left Decimal
Amps, +DC, 1000uA	Microamps, Right Decimal
Amps, +DC, 100uA	Microamps, Center Decimal
Amps, +DC, 10uA	Microamps, Left Decimal
10 Amps, +DC	Amps, Left Decimal, USE 750
Ohms	Ohms
Volts, Hz x 1, Setting 1.0000	Volts, Left Decimal, AC
Volts, Hz x 1, Setting 0.0000	Volts, Left Decimal, AC, SETTING ERROR

LED DISPLAY AND SWITCH POSITION RELATION

One of the most common logic failures is for the output of a logic gate to assume a level which is neither asserted nor negated (e.g. +1.5V for TTL: Below the 2.0V high and above the .8V low thresholds).

4.6.5 Standby/Operate Malfunctions

Select +DC Volts, 10V, Setting 0.0000 and observe the standby green display. If no display, first turn off power!! Check the leds. If led is defective replace with a suitable LED. If led is operable, check circuitry (see 07-111-001, 1/4 page 6-12). Start with Q3 and trace backwards for a logical inconsistency

If Standby is displayed, press Operate. The Operate red led should now be illuminated. The green Standby led should be extinguished. If this does not occur, check the Operate led; if defective, replace; otherwise, check circuits of 07-111-001, 1/4 page 6-12. Read pages 3-24, and 25, paragraph 3.5.2.

The operation of the Standby/Operate function is traced from S19 and 20 on 07-101-001, page 6-9 through Multiplexer IC11 on 07-111-001, 4/4 page 6-15 to IC49 and IC36 on 07-111-001, 1/4 page 6-12.

The most common reason for failure to obtain the Operate state or to obtain the operate state immediately followed by a Standby state are:

4.6.5.1 Failure of One or More IC's Driving IC34 Pins 1, and 2, Page 6-13

These circuits are intended to inhibit operation in certain undesirable switch settings (i.e. MSD "0" in AC).

4.6.5.2 Power Amp Overdrive Signal Asserted (low) IC47 pin 9

4.6.5.2.1 This occurs in one case due to failure elsewhere causing the power amplifier output to exceed approximately 16 volts, the integrator to exceed 11 volts or the current guard signal to exceed 6 volts and is discussed later.

4.6.5.2.2 Occasionally the sense circuitry generating the output exceeded signal is defective. This circuitry is on the backplane and is described on schematic 07-000-001, 2/2 page 6-7. Check as follows to see if any of the normal inputs to the sense circuit have triggered the output exceeded signal.

1. AC Control Reference TP4 triggers standby if $> +11V$ or $< -11V$.
2. MSA/PA J6 pins 79, 80, 83 and 84 triggers standby if $> +6V$ or $< -6V$.
3. MSA/PA TP10 triggers standby if $> +16V$ or $< -16V$.

If any of these are true the failure mode is in other circuits discussed below. If none of these is true and yet Operate fails to occur because J1-97 is low, check the circuits of AR3, AR4, IC1 and IC2 on 07-000-001, 2/2 page 6-7 (page 6-3 for locations).

4.6.5.3 Output I Exceeded Signal Asserted (low) at 07-111-001, 2/4 Page 6-13, IC47-10

This usually occurs because excessive current flows in the output transistors Q2, 3, 4 and 5 of schematic 07-100-001, 2/2 page 6-7. An average current of 2.5 Amperes is excessive and triggers standby. The output current is measured across **Floating** .1 ohms resistors R6 and R11 in series with the output transistors. The voltage across R6 and R11 is sensed by transistors Q6 and Q4 of 07-111-001, 2/4 and eventually generates the I out exceeded signal (low).

One of the problems in determining the malfunctions above is that the fault causing the transition to standby may disappear when standby occurs. So the occurrence of I Out exceeded or E Out exceeded **should be observed with an oscilloscope**. It will usually look like a pulse occurring about 60 milliseconds after pressing the Operate control and lasting approximately 500 milliseconds thereafter.

4.6.6 General Troubleshooting for the Series 710

Follow the checks above to check supplies, display logic and Standby/Operate function. If these functions are working, but specified performance can not be obtained, try to isolate the fault, if possible, by function (i.e. +DCV less than 10V, ACI 100uA, etc.), and then by specific circuit.

A 3 1/2 digit multimeter and an oscilloscope are usually sufficient tools when the fault causes an easily noticeable change in performance. If the failure results in marginal performance (slightly out of specification limits), then equipment similar to that of Table 4-1 may be required.

If replacement modules are available, these may be used to isolate the failure to one or more plug in modules, but eventually the failure must be traced to the component level. It is, however, quite important to isolate the fault to the Control Logic or the Multiplexer module. If the malfunction is isolated to one of these modules the schematics 07-111-001 and 07-113-001 are used to trace logic failures.

If the fault is not a logic failure the individual performance modes must be checked.

4.6.6.1 Faulty Operation in +DC Volts < 10

Refer to the system diagram shown on page 3-19 and the individual schematics called out on the system diagram. Establish the condition +DC V, 10V, OPERATE.

Try to achieve the operate state and trace the forward signal along the dark black line starting with TP5, the output of AR5 on the "REF" module, approximately +8 volts for Model 710. Move to TP6, the output of AR8 on "REF". In the operate mode it has the value -8.000 volts; in standby this voltage is -6 volts approximately.

Set the MSD dial to 10 (to obtain 10.000 volts). In the

operate mode, check the performance of U37 and U35 on the "ATTEN". Measure the DC voltage at U37, Q3 and U35, Q3 collectors as approximately -8.000 volts. Examine the common junction of R77, 79, 83, etc. and TP4 of the MSA to be less than 1 millivolt.

Examine the point TP6 on the MSA/PA to be about + 4 volts.

The following are possible malfunctions:

- 4.6.6.1.1 -8.000 Reference inaccurate - check circuits of the Reference Assembly.
- 4.6.6.1.2 One or more switches U30 through U45 (on ATTEN) are defective. See typical circuit diagram of U30 through U45 on page 6-22.
- 4.6.6.1.3 Relays Output Sense K3 (or K4 in 1000mV range) K6 or K11 open. Will cause transition to standby.
- 4.6.6.1.4 If output near normal, but erratic; check relay contact resistance (K3 or K4) K6, or K11 or K1, K2 and K3 of MSA/PA.
- 4.6.6.1.5 Defective switch MSA/PA U8, 9, 17, 18, 13 or AR4, 5.
- 4.6.6.1.6 Power Amplifier circuit failure.

Measure output transistors' current by measuring the drop across R6 and R11 of page 6-7, .15 to .45 volts is normal. Refer now to page 6-29. Use a moving coil multimeter (such as the Simpson Model 260 or Weston 660) and measure the base-emitter drops of all transistors. Make sure none is cut off. Measure the emitter to collector voltage to make sure none is saturated or shorted. If necessary, shut off power, remove MSA/PA module and check continuity of all transistors. With power off check Q2, 3, 4, and 5 on rear panel (see page 6-7).

- 4.6.6.1.8 If the operation is normal in +DC. 10V or (100mV) but malfunction in -DC V. 10V (or -1000mV), the trouble can usually be traced to the components near AR2 of the MSA/PA such as: (see page 6-27) U5, K1, K2, K3, AR2 or 3. The voltage at TP5 (output of AR2) is +8.000V DC.

4.6.6.2 Faulty Operation in AC Voltage

(This presumes the operation DCV, 10V has been checked and found satisfactory). Refer to page 3-17. Select V, Hzx10, X.000, Freq. 40, OPERATE.

In normal operation, the voltage at the output of the integrator (TP4 on AC Control and Reference) is +2 volts DC, with a small superimposed 400Hz or 800Hz signal.

The output of the Oscillator is a distortionless, 400Hz

sine wave, approximately 5 volts peak in amplitude.

The output of AR1 of the MSA/PA is approximately 6 volts peak in amplitude. (See TP2 of the MSA/PA). The output of AR9, MSA/PA is also 6 volts peak in amplitude. There is no test point for this location; it is best observed by locating the MSA/PA on an extender. The output of the Power Amplifier is 14.14 volts peak in amplitude at TP10 on the MSA/PA.

The output of the Main Summing Amp., TP6 on the MSA/PA is 7.07 volts peak in amplitude.

The output of the Rectifier is (at TP7 of the AC Control/Ref.) a half sine wave with an amplitude of 7.07 volts.

4.6.6.2.1 How to Trace Signals in AC Voltage Mode (Refer to Page 3-17)

Make sure the REF. and the ATTEN. circuits operate correctly as described in paragraph 4.6.5.2 above.

4.6.6.2.1.1 If there is no output but the Operate Led stays on when operate is pressed. The negative current flowing from ATTEN through K1, K2 should force the Integrator DC output positive in the absence of any AC output. If this has not happened the fault is probably in the Integrator; possibly U2 around the Integrator is activated. When the Integrator output reaches +11 volts, Standby should be triggered.

4.6.6.2.1.2 If There is Momentary Output Followed by a Transition to Standby Occurs

This indicates the Integrator output went positive and caused a build up of oscillation in the oscillator. The power Amplifier (PA) output therefore became so large that it tripped the standby circuit. The fault is in the components along the dotted path starting at the Sense High (SH) terminal. The signal from the Rectifier is not present, or is too small to balance the signal from the ATTEN.

Observe the outputs of the MSA, TP2 of the MSA/PA and the Rectifier, TP7 of the AC Control/Reference to see if any AC Signal is present. If none is present at the MSA output (TP6), examine it's circuits closely. If there is a signal present at the MSA but none at the Rectifier output (TP7), examine the Rectifier circuits and relay K1. Make sure K3 is operating.

4.6.6.2.1.3 If there is no Momentary AC Output but a Transition to Standby Occurs

The fault is probably in the Oscillator circuits, the leveling circuits, AR1 or AR9 of the MSA/PA. As before, trace the signal from the Integrator DC output (which goes positive to the point where it triggers Standby) to the Oscillator modulator AR5. Examine the Ø Oscillator output at AR2 (TP3) of the Oscillator. If it is a

momentarily increasing AC voltage until standby is triggered, the Oscillator is operative. If not, check the circuits of the Oscillator, including AR4 and AR5 and associated switches.

Proceed to check AR1 and AR9 or the MSA/PA likewise.

4.6.6.2.2 Voltage Greater Than 10 VAC

The model 710 operates in the same way for voltages greater than 10VAC output as for voltages less than 10 VAC output, except transformers are connected to the Power Amplifier output to boost the voltage to 100 or 1000 VAC. These transformers are labeled T2, T3 and T4. The resistors connecting the sense high (SH) to the MSA have the approximate values 100K for the 10V range and 1 Meg for the 1000V range.

4.6.6.2.2.1 If the operation is satisfactory for AC voltages below 10V but not for voltages greater than 10V and:

4.6.6.2.2.2 The Operate State Cannot be Achieved

Possibly the problem is in the circuits connecting the Power Amplifier output to the output high (OH) terminal, or in the circuits of the dotted path.

WARNING - WATCH OUT FOR HIGH VOLTAGE

4.6.6.2.2.3 The Operate Condition Occurs, but Errors are Noticed

Examine the Power Amplifier output (TP10) of the MSA/PA to see if there is any distortion noticeable. If there is, one or more components in the Power Amplifier may be defective. See Section 4.6.5.2.6 above.

4.6.6.2.3 Malfunctions Arising When Frequency is Changed (Rare)

Most of the changes in circuit configuration associated with frequency occur in the Oscillator and Integrator. Incorrect scaling can occur due to failure of the switching circuits on the Oscillator. This is rare. The Integrator time constants change from one value for less than 1000Hz. to another value for 1000 to 10000Hz. and a third value above 10000Hz.

A different high voltage transformer (1000V) is used for frequencies below (T3) and above 1000Hz (T4).

4.6.6.3 DC Voltage Greater than 10 Volts (see page 3-18)

This configuration uses most of the circuits previously described but in a different arrangement. The operation in DC voltage less than 10 volts and AC voltage configurations should be tested first and made to operate satisfactorily.

The circuits consist of a loop within a loop. The "REF" and "ATTEN" apply current to the MSA, which is connected as an inte-

grator. The MSA DC output controls the magnitude of the Oscillator AC output at 5kHz (the diagram showing 1000Hz is in error). The Oscillator AC output is leveled and amplified, transformed to a higher voltage, rectified and filtered for the DC output.

The feedback or control path is from the Sense High (SH) terminal through relays and resistors to the MSA input, where the balance is performed.

The most likely failures are in the high voltage circuits on the Output Sense Module, one of the recifier diodes (CR1-4 of the 07-121-000, see page 6-31) or a relay arcing, see paragraph 4.6.2.2 above.

4.6.6.3.1 Circuit Tracing for DC Voltage >10 Volts

Establish a setting of X0.00 on the 100 volt, +DC range. Press the Operator Control. If the Model 710 does not remain in the operate state, but trips to standby, observe the voltages in the following paragraphs just prior to tripping to standby.

4.6.6.3.1.1 Trip to Standby but No DC Output Occurs

Examine the Power Amplifier output at TP10 on the MSA/PA to see if a 5000Hz sine wave is present. If it is, and still no DC output occurs, the malfunction is between the Power Amplifier and the output terminal (OH).

4.6.6.3.1.2 Examine the output of the MSA at TP6 of the MSA/PA; it should be a positive going DC voltage. Trace the DC to the output of gate U5 Q3 collector on the AC Control/Reference.

Observe the Integrator output at TP4 of the AC Control/Reference. It is normally 0 $\pm$ 2 volts. Check the signal on pin 6, K3 of the AC Control/Reference (see page 6-24). It should be a negative going half sine wave.

Observe the signal at K1, pin 6 of the AC Control/Reference. It should be a full sine wave.

If any of the preceeding signals fail to be observed, examine the elements in the path of the defective signal. If all the preceeding signals are **present**, but the output of the MSA at TP6 of the MSA/PA becomes large enough to trip the standby function, the signals are not conducted from the sense high (SH) to the input of the MSA.

4.6.6.4 DC Current Malfunctions

Possible malfunctions (all on MSA/PA)

Relay K4 has poor contacts from pin 6 and 7.
Poor contacts on one or more of K5 through K9. Insure the sockets make a good contact with the base pins of the relays. AR6 or AR7 noisy or defective.

4.6.6.4.1 DC Current Circuit tracing (see diagram page 3-21)

To trace the performance in this mode establish the conditions Amps, +DC, 1000uA range with an amplitude setting of X00.0. If the Model 600 operates properly in the +dc voltage mode, 10 volt range, the connections from the Reference to the Attenuator, from the Attenuator to the input of the MSA and from the MSA through U13 to the Power Amplifier should operate properly, assuming no malfunction in the Control Logic or Multiplexer.

1. Connect a short from the Output High to the Output Low terminals and press operate.

2. Measure the voltage from the Sense low terminal to TP9 of the MSA/PA. It should be less than 150 microvolts. If the reading is much larger, examine the path through relays K11, K10, and K9 of the Output Sense to insure continuity. Next measure the voltage at TP7 of the MSA/PA; it should be less than 400 microvolts. If it is greater than 1 millivolt examine AR6 and AR7 for correct function.

3. Measure the voltage from TP8 to TP9 of the MSA/PA Module, with the low lead of the voltmeter on TP9. The reading should be +5.5555 volt.

If the voltage is not 5.5555 or adjustable to that value by potentiometer R72, examine the path through R60, R61, R62, R63 and through K4 terminals 6 and 7.

4. Replace the short from Output High to Output Low terminals with a 1000 ohm (+10%) resistor, measuring the voltage from TP8 to TP9 as above. It should remain at 5.5555 volts. If not, examine the path through AR6 and AR7. Measure the voltages from Sense Low to TP9 and from Sense Low to TP7. Unless they are equal in magnitude and opposite in sign, a fault exists in the path AR6 through AR7.

5. Place an ammeter from Sense High to Sense Low terminals, removing the 1000 ohm resistor. It should read 1000.0 microamps +0.2 microamps. If it does not, suspect the value of the 5000 ohm shunt R99 or the relays K5-9.

6. Verify the operation of the other ranges using the ammeter. The resistor having the most influence on each range accuracy is as follows:

1000mA	R19	(mounted on rear guard cage)
100mA	R107	
10mA	R102	
1000uA	R99	
100uA	R98	
10uA	R97	

Errors in excess of specification limits on the 10 or 100uA ranges can be caused by too large a bias current in AR7 or leakage through diodes CR14 and CR15 of the MSA/PA.

4.7 AC Current (page 3-20)

Always check dc current operation before the ac current. If the dc current operation is satisfactory, but the ac current is not, examine the output of AR2 on the MSA/PA, TP5. It should be an ac voltage with an RMS value equal to the value (.XXXX) 8 volts, where XXXX is the setting of the Model 710.

Malfunctions in K2 of the AC Control/Reference U5 or K3 of the MSA/PA can affect the operation of ac current.

APPLYING POWER TO MODEL 710 AFTER EXTENSIVE REPAIRS.

After all boards have been installed and tested, set Calibrator to 1.000V on 10V range, 500Hz. Attach a moving coil meter set to 0.5 volts dc range across R6 (1 ohm on back panel). Attach an oscilloscope to TP10 on MSA/PA board. Turn unit on, watching meter, which is monitoring the quiescent current. The voltage should be less than 0.5V. Adjust pot R133 on PA board to bring quiescent current to .15V. Check R16 (the other 1 ohm resistor). It should read the same.

Set Calibrator to "OP". It should not trip. Turn the amplitude slowly up to 10, watching the oscilloscope. There should be a clean sine wave approximately 30V PP. Increase voltage slowly to 10V at -dc, then +dc. (Oscilloscope set on dc). Go to 100V range, then 1000V range increasing from 1 to 10 in each mode (+dc and ac). Frequency on DC > 10 is approximately 5kHz.

Look at output with a DVM meter and run through all modes and ranges with amplitude set 10000.

Check digits at 10V +dc.
Check deviation.

SECTION 5.1
LIST OF RECOMMENDED SPARE PARTS

5.1 List of Recommended Spares Parts - Model 710

Description	Rotek P/N	Mfg. Code	Mfg. P/N	Quantity
Integrated Circuits - Linear				
Amplifier	ICLOAAD301AN	24355	AD301AN	1
Regulator	REG05VP0501A	07263	uA309KC	1
Op Amp	ICLOAAD518JH	24355	AD518JH	1
Regulator	REG15VNEG01A	27014	LM320K-15	1
Regulator	REG15VPOS01A	27014	LM340K-15	1
Op Amp	ICLOALNX07CJ	06665	OP-07CJ	1
Op Amp	ICLOAAD741LH	24355	AD741LH	1
Modulator	ICLMODXX1496	04713	MC1496G	1
Op Amp	ICLOACSX7650	95014	ICL7650ITV	1
Blower				
	FANLOVL8500P	23936	8500P	1
	FANHIVLBT2A1	82877	BT2A1	1
Diodes and Zener Diodes				
Signal	DIOCRN914XXX	07263	1N914	2
Zener	DIOVR0102974	18778	1N2974A	1
Rectifier	DIOCR4002XXX	04713	1N4002	1
Zener	DIOVR6R25234	07263	1N5234B	1
Zener	DIOVR0105240	07263	1N5240B	1
Indicators				
Led Red	DISLEDREDSML	02131	MV5774C	1
Fuses				
4A SB	FUSE4.00S250	75915	326004	5
2.5A SB	FUSE2.50S250	75915	32602.5	5
5A SB	FUSE5.00S250	75915	313005	10
Integrated Circuits -Digital				
Nand Gate	ICDNANDXLS00	27014	DM74LS00	2
Nand Gate	ICDNANDXXX00	18324	7400N	1
Nand Gate	ICDNANDXLS10	01295	SN74LS10	1
Decoder	ICDDECXXLS42	27014	DM74LS42	1
Latch	ICDLATCHLS75	01295	SN74LS75	2
Multivibrator	ICDMULTLS122	27014	DM74LS122	1
Multivibrator	ICDMULTLS123	27014	DM74LS123	1
Multiplexer	ICDMPXRLS157	01295	SN74LS157	1
Relays				
2PDT 1500V	REL2PDTSTDHV	92714	AZ420-70-219	5
4DPT 1500V	REL4PDTSTDHV	92714	AZ421-70-220	5

Transistors

Dual NPN	TRASN2060XXX	07933	2N2060	1
Switch PNP	TRASP2946XXX	07933	2N2946A	1
Small Signal NPN	TRASN3019XXX	07263	2N3019	1
Small Signal PNP	TRASP4033XXX	07263	2N4033	1
FET N-Channel	TRAFN4860XXX	04713	2N4860	1
FET NPN (CMOS)	TRAFNF231XXX	81483	IRF231	1
FET PNP (CMOS)	TRAFP9132XXX	81483	IRF9132	1
Signal NPN	TRASNSA05XXX	09212	MPSA05	1
Signal PNP	TRASPSA55XXX	09212	MPSA55	1
Power PNP	TRASP6052XXX	04713	2N6052	1

Switches

Thermal Switch	SWITHM1807BT	82647	7BTL5B-13	1
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SECTION 5.2
TABLE OF REPLACEABLE PARTS

Table of Replaceable Parts

NOTES:

Note 1: All Resistor values are in Ohms.

Note 2: All "Resistor W.W." will have a tolerance of $\pm .05\%$ and a temperature coefficient of 5PPM unless otherwise specified.

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
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Integrated Circuits Linear

AR1	Regulator	REG15VPOS01A	07263	UA7815KC
AR2	Regulator	REG15VNEG01A	07263	UA7915KC
AR3	Op Amp	ICLOAAD301AH	24355	AD301AH
AR4	Op Amp	ICLOAAD301AH	24355	AD301AH
AR5	Regulator	REGVARPOS.5A	07263	LM317T

Blowers and Fans

B1	Pentaflow Low Vel.	FANLOVL8500P	23936	8500P
B2	Biscuit High Vel.	FANHIVLBT2A1	82877	028448

Capacitors

C1	Film 0.22uf	CAPPE2203100	56289	225P22491XD3
C2	Film 0.22uf	CAPPE2203100	56289	225P22491XD3
C3	Film 0.22uf	CAPPE2203100	56289	225P22491XD3
C4	Film 0.22uf	CAPPE2203100	56289	225P22491XD3
C5	Film 0.1uf	CAPPE1003200	56289	192P10492
C6	Film 0.1uf	CAPPE1003200	56289	192P10492
C7	Film 0.1uf	CAPPE1003200	56289	192P10492
C8	Film 0.1uf	CAPPE1003200	56289	192P10492
C9	Elect. 16000uf	CAPCG1608050	56289	36DX163G050B
C10	Elect. 16000uf	CAPCG1608050	56289	36DX163G050B
C11	Elect. 820uf	CAPCG8206075	37942	CGS821U075BBI
C12	Elect. 18000uf	CAPCG1808015	37942	CG183U015R4C
C13	Tantalum 4.7uf	CAPTA4704035	37942	TDC475M035FL
C14	Tantalum 4.7uf	CAPTA4704035	37942	TDC475M035FL
C15	Tantalum 4.7uf	CAPTA4704035	37942	TDC475M035FL
C16	Tantalum 4.7uf	CAPTA4704035	37942	TDC475M035FL
C17	Film 0.22uf	CAPPE2203100	56289	225P22491XD3
C18	Polycarbonate 2uf	CAPPC2004050	90670	RA1A205
C19	Elect. 13000uf	CAPCG1308025	37942	CGS133U025R4
C20	Elect. 13000uf	CAPCG1308025	37942	CGS133U025R4
C21	Alum. Elect. 47uf	CAPAL4705050	NIC500	TLB1H470M
C22	Dipped Mica 33pf	CAPDM33XX500	14655	CD15ED330J03
C23	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C24	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C25	Polycarbonate 4uf	CAPPC4004050	90670	RA1A405
C26	Dipped Mica 33pf	CAPDM33XX500	14655	CD15ED330J03
C27	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C28	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C29	Dipped Mica 1000pf	CAPDM1001500	14655	CD19FD102J03
C30	Not Used			
C31	Not Used			
C32	Alum. Elect. 10uf	CAPAL1005050	MAR6116	CEO2WH100C
C33	Alum. Elect. 10uf	CAPAL1005050	MAR6116	CEO2WH100C
C34	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C35	Cer. Disc 0.01uf	CAPCD1002100	04222	TG-S10
C36	Cer. Disc 0.01uf	CAPCD1002100	04222	TG-S10
C37	Cer. Disc 0.1uf	CAPCD1003050	04222	3429050E104M
C38	Elect. 750uf	CAPCG7506040	56289	39D757G040GL
C39	Elect. 750uf	CAPCG7506040	56289	39D757G040GL
C40	Cer. Disc 0.01	CAPCD1002100	56289	TG-S10

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
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C41	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
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Diodes

CR1	Signal	DIOCRN914XXX	07263	1N914
CR2	Signal	DIOCRN914XXX	07263	1N914
CR3	Rectifier	DIOCR4002XXX	04713	1N4002
CR4	Rectifier	DIOCR4002XXX	04713	1N4002
CR5	Signal	DIOCRN914XXX	07263	1N914
CR6	Signal	DIOCRN914XXX	07263	1N914
CR7	Signal	DIOCRN914XXX	07263	1N914
CR8	Signal	DIOCRN914XXX	07263	1N914
CR9	Signal	DIOCRN914XXX	07263	1N914
CR10	Rectifier	DIOCR4002XXX	04713	1N4002
CR11	Rectifier	DIOCR4002XXX	04713	1N4002
CR12	Rectifier	DIOCR4002XXX	04713	1N4002
CR13	Rectifier	DIOCR4002XXX	04713	1N4002
CR14	Signal	DIOCRN914XXX	07263	1N914
CR15	Signal	DIOCRN914XXX	07263	1N914
CR16	Signal	DIOCRN914XXX	07263	1N914
CR17	Signal	DIOCRN914XXX	07263	1N914
CR18	Signal	DIOCRN914XXX	07263	1N914
CR19	Signal	DIOCRN914XXX	07263	1N914
CR20	Signal	DIOCRN914XXX	07263	1N914
CR21	Rectifier	DIOCR4002XXX	04713	1N4002
CR22	Rectifier	DIOCR4002XXX	04713	1N4002
CR23	Rectifier	DIOCR4002XXX	04713	1N4002
CR24	Suppressor	DIOTS0335645	24444	1N5645
CR25	Signal	DIOCRN914XXX	07263	1N914
CR26	Signal	DIOCRN914XXX	07263	1N914
CR27	Signal	DIOCRN914XXX	07263	1N914
CR28	Rectifier	DIOCR4002XXX	04713	1N4002
CR29	Rectifier	DIOCR4002XXX	04713	1N4002
CR30	Rectifier	DIOCR4002XXX	04713	1N4002
CR31	Rectifier	DIOCR4002XXX	04713	1N4002
CR32	Rectifier	DIOCR4002XXX	04713	1N4002
CR33	Rectifier	DIOCR4002XXX	04713	1N4002

Integrated Circuits Digital

IC1	Nand Gate	ICDNANDXXS00	27014	74S00
IC2	Multivibrator	ICDMULTLS123	27014	DM74LS123
IC3	Nand Gate	ICDNANDXLS00	27014	74LS00

Relays

K1	2PDT 1500V	REL2PDTSTDHV	92714	AZ420-70-219
K2	4PDT 1500V	REL4PDTSTDHV	92714	AZ421-70-220
K3	2PDT 1500V	REL2PDTSTDHV	92714	AZ420-70-219
K4	2PDT 1500V	REL2PDTSTDHV	92714	AZ420-70-219
K5	2PDT 1500V	REL2PDTSTDHV	92714	AZ420-70-219
K6	2PDT	REL2PDTSTDLP	92714	AZ420-V50-40L
K7	4PDT 1500V	REL4PDTSTDHV	92714	AZ421-70-220
K8	2PDT 1500V	REL2PDTSTDHV	92714	AZ720-70-219

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
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Transistors

Q1	Signal PNP	TRASPSA55XXX	09212	MPSA55
Q2	Signal NPN	TRASPSA05XXX	09212	MPSA05
Q3	Signal NPN	TRASN3019XXX	07263	2N3019

Bridge Rectifiers

RU1	Full Wave Bridge	DIOBRFWLC300	02131	KBU6D
RU2	Full Wave Bridge	DIOBRFWLC300	02131	KBU6D
RU3	Full Wave Bridge	DIOBRFWLC300	02131	KBU6D

Resistors

R1	MF 5.11K	RESMF5111XXX	16299	SMA-4
R2	MF 348	RESMF348XXXX	16299	SMA-4
R3	MF 10K	RESMF1002XXX	16299	SMA-4
R4	MF 1K	RESMF1001XXX	16299	SMA-4
R5	Power 50	RESHP50XXX10	24681	MZ10-50
R6	MF 10K	RESMF1002XXX	16299	SMA-4
R7	Power 10	RESHP10XXX10	24681	MZ10-10
R8	MF 10K	RESMF1002XXX	16299	SMA-4
R9	MF 1K	RESMF1001XXX	16299	SMA-4
R10	Power 10	RESHP10XXX10	24681	MZ10-10
R11	MF 348	RESMF348XXXX	16299	SMA-4
R12	MF 10K	RESMF1002XXX	16299	SMA-4
R13	MF 2.15K	RESMF2151XXX	16299	SMA-4
R14	MF 14.7K	RESMF1472XXX	16299	SMA-4
R15	MF 14.7K	RESMF1472XXX	16299	SMA-4
R16	MF 51.1	RESMF51R1XXX	16299	SMA-4
R17	MF 51.1	RESMF51R1XXX	16299	SMA-4
R18	MF 2.15K	RESMF2151XXX	16299	SMA-4
R19	MF 14.7K	RESMF1472XXX	16299	SMA-4
R20	MF 51.1	RESMF51R1XXX	16299	SMA-4
R21	MF 51.1	RESMF51R1XXX	16299	SMA-4
R22	MF 1K	RESMF1001XXX	16299	SMA-4
R23	WW 10	RESPW10XX500	58880	1250
R24	Power 20	RESHP20XXX10	24681	MZ10-20
R25	Power 1K	RESHP1001X10	24681	MZ10-1K
R26	Power 5.61	RESHP5R61X50	91637	SPR-417
R26A	Power 1	RESHP1XXXX10	24681	MZ10-1
R27	Power 20	RESHP20XXX10	24681	MZ10-20
R28	MF 1K	RESMF1001XXX	16299	SMA-4
R29	MF 2.15K	RESMF2151XXX	16299	SMA-4
R30	MF 2.15K	RESMF2151XXX	16299	SMA-4
R31	MF 100	RESMF100XXXX	16299	SMA-4
R32	MF 100	RESMF100XXXX	16299	SMA-4
R33	MF 21.5K	RESMF2152XXX	16299	SMA-4
R34	MF 51.1K	RESMF5112XXX	16299	SMA-4
R35	MF 348	RESMF348XXXX	16299	SMA-4
R36	MF 21.5K	RESMF2152XXX	16299	SMA-4
R37	Power 20	RESHP20XXX50	24681	RH50-20
R38	MF 1K	RESMF1001XXX	16299	SMA-4

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
R39	MF 3.48K	RESMF3481XXX	16299	SMA-4
R40	MF 51.1K	RESMF5112XXX	16299	SMA-4
R41	MF 100	RESMF100XXXX	16299	SMA-4
R42	MF 511	RESMF511XXXX	16299	SMA-4
R43	WW 1	RESPW1XXX500		
R44	WW 1	RESPW1XXX500		
R45	PF 1K	RESPF1001050		

Transformers

T1		XFMR06000051	06678	
T2		XFMR06000018	06678	
T3		XFMR03000019	06678	
T4		XFMR03000020	06678	

Zener Regulators

VR1	Zener 5.1V	DIOVR5R11531	07263	1N5231B
VR2	Zener 5.1V	DIOVR5R11531	07263	1N5231B
VR3	Zener 10V	DIOVR0105240	07263	1N5240B
VR4	Zener 10V	DIOVR0105240	07263	1N5240B
VR5	Zener 5.6V	DIOVR5R65232	61725	1N5232B
VR6	Zener 5.6V	DIOVR5R65232	61725	1N5232B

Metal Oxide Varistors

MOV1	420V	VARV420LA20A	09212	V420LA20A
MOV2	420V	VARV420LA20A	09212	V420LA20A
MOV3	420V	VARV420LA20A	09212	V420LA20A

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
Capacitors				
C1	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C2	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C3	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C4	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C5	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C6	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C7	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C8	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C9	Polycarb 0.22uf	CAPPC2203100	90670	DP2B224K
C10	Polycarb 0.47uf	CAPPC4703100	90670	DP2B474K
C11	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C12	Polycarb 0.1uf	CAPPC1003100	90670	DP2B104K
C13	Dipped Mica 100pf	CAPDM100X500	14655	CD15FD101J03

Diodes				
CR1	Signal	DIOCRN270XXX	18778	1N270
CR2	Signal	DIOCRN270XXX	18778	1N270
CR3	Signal	DIOCRN270XXX	18778	1N270
CR4	Signal	DIOCRN270XXX	18778	1N270
CR5	Signal	DIOCRN270XXX	18778	1N270
CR6	Signal	DIOCRN270XXX	18778	1N270
CR7	Signal	DIOCRN270XXX	18778	1N270
CR8	Signal	DIOCRN270XXX	18778	1N270
CR9	Signal	DIOCRN270XXX	18778	1N270
CR10	Signal	DIOCRN270XXX	18778	1N270
CR11	Signal	DIOCRN270XXX	18778	1N270
CR12	Signal	DIOCRN270XXX	18778	1N270
CR13	Zener	DIOVR5R15231	07263	1N5231B

Indicators				
DS1	Small Red	DISLEDREDSML	02131	MV5774C
DS2	Small Red	DISLEDREDSML	02131	MV5774C
DS3	Small Red	DISLEDREDSML	02131	MV5774C
DS4	Small Red	DISLEDREDSML	02131	MV5774C
DS5	Small Red	DISLEDREDSML	02131	MV5774C
DS6	Small Red	DISLEDREDSML	02131	MV5774C
DS7	Small Red	DISLEDREDSML	02131	MV5774C
DS8	Small Red	DISLEDREDSML	02131	MV5774C
DS9	Small Red	DISLEDREDSML	02131	MV5774C
DS10	Small Red	DISLEDREDSML	02131	MV5774C
DS11	Small Red	DISLEDREDSML	02131	MV5774C
DS12	Small Red	DISLEDREDSML	02131	MV5774C
DS13	Small Red	DISLEDREDSML	02131	MV5774C
DS14	Small Red	DISLEDREDSML	02131	MV5774C
DS15	Small Red	DISLEDREDSML	02131	MV5774C
DS16	+/-	DISSEGRED+-1	02131	MAN73A/B
DS17	7 Segment	DISSEGRED0-9	02131	MAN72A/B
DS18	7 Segment	DISSEGRED0-9	02131	MAN72A/B
DS19	7 Segment	DISSEGRED0-9	02131	MAN72A/B

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
DS20	Part of S33			
DS21	Small Red	DISLEDREDSML	02131	MV5774C
DS22	Small Green	DISLEDGRNSML	02131	MV5474C

Integrated Circuit Digital

IC1	DEC-BCD Decoder	ICDENCDLS147	01295	74LS147
IC2	DEC-BCD Decoder	ICDENCDLS147	01295	74LS147
IC3	DEC-BCD Decoder	ICDENCDLS147	01295	74LS147
IC4	DEC-BCD Decoder	ICDENCDLS147	01295	74LS147
IC5	DEC-BCD Decoder	ICDENCDLS147	01295	74LS147
IC6	DEC-BCD Decoder	ICDENCDLS147	01295	74LS147
IC7	DEC-BCD Decoder	ICDENCDLS147	01295	74LS147
IC8	Nand Gate	ICDNANDXLS00	27014	74LS00
IC9	Meter IC	ICDMETER7107	32293	ICL7107CPL

Resistors

R1	MF 1.47K	RESMF1471XXX	16299	SMA-4
R2	MF 21.5K	RESMF2152XXX	16299	SMA-4
R3	MF 348	RESMF348XXXX	16299	SMA-4
R4	MF 348	RESMF348XXXX	16299	SMA-4
R5	MF 348	RESMF348XXXX	16299	SMA-4
R6	MF 68.1K	RESMF6812XXX	16299	SMA-4
R7	MF 348	RESMF348XXXX	16299	SMA-4
R8	MF 348	RESMF348XXXX	16299	SMA-4
R9	MF 348	RESMF348XXXX	16299	SMA-4
R10	MF 348	RESMF348XXXX	16299	SMA-4
R11	MF 348	RESMF348XXXX	16299	SMA-4
R12	MF 348	RESMF348XXXX	16299	SMA-4
R13	MF 348	RESMF348XXXX	16299	SMA-4
R14	MF 348	RESMF348XXXX	16299	SMA-4
R15	MF 348	RESMF348XXXX	16299	SMA-4
R16	Dual Variable 5/10K	RESVFC25M361	01121	25M361
R17	Variable 1K	RESVF1001X89	73138	89PR1K
R18	MF 51.1K	RESMF5112XXX	16299	SMA-4
R19	MF 1Meg.	RESMF1004XXX	16299	SMA-4
R20	MF 100K	RESMF1003XXX	16299	SMA-4
R21	MF 2.15K	RESMF2151XXX	16299	SMA-4
R22	MF 215	RESMF215XXXX	16299	SMA-4
R23	MF 215	RESMF215XXXX	16299	SMA-4
R24	Part of R16			
R25	MF 14.7K	RESMF1472XXX	16299	SMA-4

Resistor Networks

RU1	47K SIP 6 pin	RESSI4702XX5	16299	LC6001-4702G
RU2	47K SIP 6 pin	RESSI4702XX5	16299	LC6001-4702G
RU3	47K SIP 6 pin	RESSI4702XX5	16299	LC6001-4702G
RU4	47K SIP 6 pin	RESSI4702XX5	16299	LC6001-4702G
RU5	47K SIP 6 pin	RESSI4702XX5	16299	LC6001-4702G
RU6	47K SIP 6 pin	RESSI4702XX5	16299	LC6001-4702G

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
RU7	47K SIP 6 pin	RESSI4702XX5	16299	LC6001-4702G
RU8	47K SIP 6 pin	RESSI4702XX5	16299	LC6001-4702G
RU9	47K SIP 6 pin	RESSI4702XX5	16299	LC6001-4702G
RU10	47K SIP 6 pin	RESSI4702XX5	16299	LC6001-4702G
RU11	47K SIP 6 pin	RESSI4702XX5	16299	LC6001-4702G
RU12	47K SIP 6 pin	RESSI4702XX5	16299	LC6001-4702G
RU13	47K SIP 8 pin	RESSI4702XX7	16299	LC8001-4702G

Transistors

Q1	Signal PNP	TRASPSA55XXX	09212	MPSA55
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Switches

S1		710104000-02	06678	
S2	Part of S1			
S3	Part of S1			
S4	Part of S1			
S5	Part of S1			
S6	Part of S1			
S7	Part of S1			
S8	Part of S1			
S9	Part of S1			
S10	Part of S1			
S11	Part of S1			
S12	Detent/Shaft	SWIDET11P009	06678	
	Wafer	SWIWAFL1P011	06678	
S13	Detent/Shaft	SWIDET11P009	06678	
	Wafer	SWIWAFL1P011	06678	
S14	Detent/Shaft	SWIDET11P011	06678	
	Wafer	SWIWAFL1P011	06678	
S15	Detent/Shaft	SWIDET11P009	06678	
	Wafer	SWIWAFL1P011	06678	
S16	Detent/Shaft	SWIDET11P009	06678	
	Wafer	SWIWAFL1P011	06678	
S17	Detent/Shaft	SWIDET11P009	06678	
	Wafer	SWIWAFL1P011	06678	
S18	Detent/Shaft	SWIDET11P009	06678	
	Wafer	SWIWAFL1P011	06678	
S19	Push button	SWIPBPB2STMO	06678	
S20	Part of S19			
S21	Push button	SWIPBPB6ST20	06678	
S22	Part of S21			
S23	Part of S21			
S24	Part of S21			
S25	Part of S21			
S26	Part of S21			
S27	Push button	SWIPBPB4ST20	06678	
S28	Part of S27			
S29	Part of S27			
S30	Part of S27			
S31	Part of S27			
S32	See Rear Panel Assy 07-105-000			

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
S33		SWIPBMPLITPP	06678	
S34		SWIRKRLITPWR	04009	
S35	Detent/Shaft	SWIDETCON017	06678	
S36	Part of S35		06678	

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
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Integrated Circuits Analog

AR1	Reg. +5V 1 Amp	REG05VP0S01A	07263	UA309KC
AR2	Not Used			
AR3	Reg. +5V 3 Amp	REG05VP0S03A	27014	LM323K

Capacitors

C1	Tantalum 4.7uf	CAPTA4704035	37942	TDC475M035FL
C2	Tantalum 4.7uf	CAPTA4704035	37942	TDC475M035FL
C3	Cer. Disc 0.05uf	CAPCD5002025	71590	UK25-503

Diodes

CR1	Rectifier	DIOCR4002XXX	04713	1N4002
CR2	Rectifier	DIOCR4002XXX	04713	1N4002

Fuses

F1	5A SB	FUSE5.00S250	75915	313005
F2	5A SB	FUSE5.00S250	75915	313005
F3	5A SB	FUSE5.00S250	75915	313005
F4	4A SB (120V)	FUSE4.00S250	75915	326004
F5	2.5A SB (220V)	FUSE2.50S250	75915	326025

Transistors

Q1	Power PNP	TRASP6052XXX	04713	2N6052
Q2	FET NPN	TRAFNF231XXX	81483	IFR231
Q3	FET NPN	TRAFNF231XXX	81483	IFR231
Q4	FET PNP	TRAFP9132XXX	81483	IFR9132
Q5	FET PNP	TRAFP9132XXX	81483	IFR9132
Q6	SCR Rectifier	TRACR4441XXX	04713	2N4441

Resistors

R1	MF 511	RESMF511XXXX	16299	SMA-4
R2	Not Used			
R3	Not Used			
R4	MF 100	RESMF100XXXX	16299	SMA-4
R5	MF 1K	RESMF1001XXX	16299	SMA-4
R6	Power .1	RESHPR1XXX10	24681	MZ10-.1
R7	MF 1K	RESMF1001XXX	16299	SMA-4
R8	MF 1K	RESMF1001XXX	16299	SMA-4
R9	MF 1K	RESMF1001XXX	16299	SMA-4
R10	MF 1K	RESMF1001XXX	16299	SMA-4
R11	Power .1	RESHPR1XXX10	24681	MZ10-.1
R12	MF 2.15K	RESMF2151XXX	16299	SMA-4
R13	MF 2.15K	RESMF2151XXX	16299	SMA-4
R14	MF 5.11K	RESMF5111XXX	16299	SMA-4

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
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Zener Diodes

VR1	Not Used			
VR2	Zener	DIOVR0102974	18778	1N2974A
VR3	Zener	DIOVR0102974	18778	1N2974A

Connectors

J33	Fused Connector	CONJKLINEVJ1	05245	6VJ1
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Switches

S32	Thermal Switch	SWITHM1807BT	82646	7BTL5B-13
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Symbol	Description	Rotek P/N	Mfg. Code.	Mfg. P/N
Capacitors				
C1	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C2	Tantalum 4.7uf	CAPTA4704035	37942	TDC475M035FL
C3	Tantalum 100uf	CAPTA1006020	56289	196D107X9020TE4
C4	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C5	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C6	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C7	Al. Elect. 100uf	CAPAL1006035	56289	TE 1211
C8	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C9	Tantalum 22uf	CAPTA2205035	56289	196DZZ6X0035
C10	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C11	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C12	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C13	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C14	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C15	Film 0.022uf	CAPPE2202100	56289	225P22391WD3
C16	Mylar 0.47uf	CAPPE4703050	14655	MMW05P47
C17	Film 0.022uf	CAPPE2202100	56289	225P22391WD3
C18	Tantalum 4.7uf	CAPTA4704035	37942	TDC475M035FL
C19	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C20	Tantalum 4.7uf	CAPTA4704035	37942	TDC475M035FL
C21	Al. Elect. 10uf	CAPAL1005050	56289	TE 1304
C22	Al. Elect. 10uf	CAPAL1004050	56289	TE 1304
C23	Al. Elect. 10uf	CAPAL1004050	56289	TE 1304
C24	Al. Elect. 10uf	CAPAL1004050	56289	TE 1304
C25	Tantalum 4.7uf	CAPTA4704035	37942	TDC475M035FL
C26	Al. Elect. 1uf	CAPAL1004050	56289	TE 1300
C27	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C28	Al. Elect. 1uf	CAPAL1004050	56289	TE 1300
C29	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C30	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10

Diodes

CR1	Signal	DIOCRN914XXX	07263	1N914
CR2	Signal	DIOCRN914XXX	07263	1N914
CR3	Signal	DIOCRN914XXX	07263	1N914
CR4	Zener 6.8V	DIOTS6R86267	24444	1.5KE6.8

Integrated Circuits Digital

IC1	Multiplexer	ICDMPXRLS157	27014	74LS157
IC2	Multiplexer	ICDMPXRLS157	27014	74LS157
IC3	Multiplexer	ICDMPXRLS157	27014	74LS157
IC4	Multiplexer	ICDMPXRLS157	02195	74LS157
IC5	Multiplexer	ICDMPXRLS157	27014	74LS157
IC6	Multiplexer	ICDMPXRLS157	27014	74LS157
IC7	Multiplexer	ICDMPXRLS157	27014	74LS157
IC8	Multiplexer	ICDMPXRLS157	27014	74LS157
IC9	Multiplexer	ICDMPXRLS157	27014	74LS157
IC10	Multiplexer	ICDMPXRLS157	27014	74LS157
IC11	Multiplexer	ICDMPXRLS157	27014	74LS157

Symbol	Description	Rotek P/N	Mfg. Code.	Mfg. P/N
IC12	Multiplexer	ICDMPXRLS157	27014	74LS157
IC13	Latch	ICDLATCHLS75	02195	74LS75
IC14	Latch	ICDLATCHLS75	02195	74LS75
IC15	Latch	ICDLATCHLS75	02195	74LS75
IC16	Latch	ICDLATCHLS75	02195	74LS75
IC17	Latch	ICDLATCHLS75	02195	74LS75
IC18	Latch	ICDLATCHLS75	02195	74LS75
IC19	Latch	ICDLATCHLS75	02195	74LS75
IC20	Latch	ICDLATCHLS75	02195	74LS75
IC21	Latch	ICDLATCHLS75	02195	74LS75
IC22	Latch	ICDLATCHLS75	02195	74LS75
IC23	Nand Gate	ICDNANDXLSOO	27014	74LSOO
IC24	Multiplexer	ICDMPXRLS157	27014	74LS157
IC25	Nand Gate	ICDNANDXXXOO	18324	74OON
IC26	Nand Gate	ICDNANDXLSOO	27014	74LSOO
IC27	Nand Gate	ICDNANDXXXOO	18324	74OON
IC28	Nand Gate	ICDNANDXXXOO	18324	74OON
IC29	Nand Gate	ICDNANDXXXOO	18324	74OON
IC30	Nand Gate	ICDNANDXXXOO	18324	74OON
IC31	Nand Gate	ICDNANDXLSOO	27014	74LSOO
IC32	Nand Gate	ICDNANDXLSOO	27014	74LSOO
IC33	Nand Gate	ICDNANDXLSOO	27014	74LSOO
IC34	Nand Gate	ICDNANDXLS10	02195	74LS10
IC35	Nand Gate	ICDNANDXLSOO	27014	74LSOO
IC36	Nand Gate	ICDNANDXLS10	02195	74LS10
IC37	Nand Gate	ICDNANDXLSOO	27014	74LSOO
IC38	Nand Gate	ICDNANDXLSOO	27014	74LSOO
IC39	Nand Gate	ICDNANDXLSOO	27014	74LSOO
IC40	Nand Gate	ICDNANDXLS10	02195	74LS10
IC41	Nand Gate	ICDNANDXLS10	02195	74LS10
IC42	Nand Gate	ICDNANDXLSOO	27014	74LSOO
IC43	Nand Gate	ICDNANDXLSOO	27014	74LSOO
IC44	Nand Gate	ICDNANDXLSOO	27014	74LSOO
IC45	Multivibrator	ICDMULTLS123	27014	74LS123
IC46	Multivibrator	ICDMULTLS123	27014	74LS123
IC47	Nand Gate	ICDNANDXXXOO	18324	74OON
IC48	Nand Gate	ICDNANDXLSOO	27014	74LSOO
IC49	Nand Gate	ICDNANDXLSOO	27014	74LSOO
IC50	Nand Gate	ICDNANDXXXOO	18324	74OON
IC51	Nand Gate	ICDNANDXXXOO	18324	74OON
IC52	Nand Gate	ICDNANDXXXOO	18324	74OON
IC53	Nand Gate	ICDNANDXLSOO	27014	74LSOO
IC54	Nand Gate	ICDNANDXXXOO	18324	74OON
IC55	Nand Gate	ICDNANDXXXOO	18324	74OON
IC56	Nand Gate	ICDNANDXLSOO	27014	74LSOO
IC57	Nand Gate	ICDNANDXXXOO	18324	74OON
IC58	Nand Gate	ICDNANDXLSOO	27014	74LSOO
IC59	Nand Gate	ICDNANDXLSOO	27014	74LSOO
IC60	Nand Gate	ICDNANDXLSOO	27014	74LSOO
IC61	Nand Gate	ICDNANDXLSOO	27014	74LSOO
IC62	Hex Inverter	ICDINVXXX06	27014	7406

Transistors

Q1 Not Used

Symbol	Description	Rotek P/N	Mfg. Code.	Mfg. P/N
Q2	Not Used			
Q3	Not Used			
Q4	Signal NPN	TRASNSA05XXX	09212	MPSA05
Q5	Signal NPN	TRASNSA05XXX	09212	MPSA05
Q6	Signal PNP	TRASPSA55XXX	09212	MPSA55

Resistors

R1	MF 51.1K	RESMF5112XXX	16299	SMA-4
R2	MF 21.5K	RESMF2152XXX	16299	SMA-4
R3	MF 21.5K	RESMF2152XXX	16299	SMA-4
R4	MF 5.11K	RESMF5111XXX	16299	SMA-4
R5	MF 5.11K	RESMF5111XXX	16299	SMA-4
R6	MF 5.11K	RESMF5111XXX	16299	SMA-4
R7	MF 5.11K	RESMF5111XXX	16299	SMA-4
R8	MF 51.1K	RESMF5112XXX	16299	SMA-4
R9	MF 51.1K	RESMF5112XXX	16299	SMA-4
R10	MF 100K	RESMF1003XXX	16299	SMA-4
R11	MF 100	RESMF100XXXX	16299	SMA-4
R12	MF 5.11K	RESMF5111XXX	16299	SMA-4
R13	MF 5.11K	RESMF5111XXX	16299	SMA-4
R14	MF 5.11K	RESMF5111XXX	16299	SMA-4
R15	MF 5.11K	RESMF5111XXX	16299	SMA-4
R16	MF 5.11K	RESMF5111XXX	16299	SMA-4
R17	MF 5.11K	RESMF5111XXX	16299	SMA-4
R18	MF 348	RESMF348XXXX	16299	SMA-4
R19	MF 10K	RESMF1002XXX	16299	SMA-4
R20	MF 10K	RESMF1002XXX	16299	SMA-4
R21	MF 681	RESMF681XXXX	16299	SMA-4
R22	MF 681	RESMF681XXXX	16299	SMA-4
R23	MF 5.11K	RESMF5111XXX	16299	SMA-4
R24	MF 348	RESMF348XXXX	16299	SMA-4
R25	MF 5.11K	RESMF5111XXX	16299	SMA-4
R26	MF 5.11K	RESMF5111XXX	16299	SMA-4
R27	MF 5.11K	RESMF5111XXX	16299	SMA-4
R28	MF 5.11K	RESMF5111XXX	16299	SMA-4
R29	MF 5.11K	RESMF5111XXX	16299	SMA-4
R30	MF 5.11K	RESMF5111XXX	16299	SMA-4
R31	MF 5.11K	RESMF5111XXX	16299	SMA-4
R32	MF 5.11K	RESMF5111XXX	16299	SMA-4
R33	MF 215	RESMF215XXXX	16299	SMA-4
R34	MF 51.1	RESMF51R1XXX	16299	SMA-4
R35	MF 51.1	RESMF51R1XXX	16299	SMA-4
R36	MF 5.11K	RESMF5111XXX	16299	SMA-4
R37	MF 100K	RESMF1003XXX	16299	SMA-4
R38	MF 100K	RESMF1003XXX	16299	SMA-4

Resistor Networks

RU1	6 Pin SIP 47K	RESSI4702XX5	16299	LC6001-4702G
RU1A	8 Pin SIP 47K	RESSI4702XX7	16299	LC8001-4702G
RU2	6 Pin SIP 47K	RESSI4702XX5	16299	LC6001-4702G
RU2A	8 Pin SIP 47K	RESSI4702XX7	16299	LC8001-4702G
RU3	6 Pin SIP 47K	RESSI4702XX5	16299	LC6001-4702G
RU3A	8 Pin SIP 47K	RESSI4702XX7	16299	LC8001-4702G

Symbol	Description	Rotek P/N	Mfg. Code.	Mfg. P/N
RU4	8 Pin SIP 47K	RESSI4702XX7	16299	LC8001-4702G
RU4A	8 Pin SIP 47K	RESSI4702XX7	16299	LC8001-4702G
RU5	6 Pin SIP 47K	RESSI4702XX5	16299	LC6001-4702G
RU5A	8 Pin SIP 47K	RESSI4702XX7	16299	LC8001-4702G
RU6	6 Pin SIP 47K	RESSI4702XX5	16299	LC6001-4702G
RU6A	8 Pin SIP 47K	RESSI4702XX7	16299	LC8001-4702G
RU7	6 Pin SIP 47K	RESSI4702XX5	16299	LC6001-4702G
RU7A	8 Pin SIP 47K	RESSI4702XX7	16299	LC8001-4702G
RU8	6 Pin SIP 47K	RESSI4702XX5	16299	LC6001-4702G
RU8A	8 Pin SIP 47K	RESSI4702XX7	16299	LC8001-4702G
RU9	6 Pin SIP 47K	RESSI4702XX5	16299	LC6001-4702G
RU9A	8 Pin SIP 47K	RESSI4702XX7	16299	LC8001-4702G
RU10	6 Pin SIP 47K	RESSI4702XX5	16299	LC6001-4702G
RU10A	8 Pin SIP 47K	RESSI4702XX7	16299	LC8001-4702G
RU11	6 Pin SIP 47K	RESSI4702XX5	16299	LC6001-4702G
RU11A	8 Pin SIP 47K	RESSI4702XX7	16299	LC8001-4702G
RU12	6 Pin SIP 47K	RESSI4702XX5	16299	LC6001-4702G
RU12A	8 Pin SIP 47K	RESSI4702XX7	16299	LC8001-4702G
RU13	6 Pin SIP 47K	RESSI4702XX5	16299	LC6001-4702G
RU13A	8 Pin SIP 47K	RESSI4702XX7	16299	LC8001-4702G
RU14	6 Pin SIP 47K	RESSI4702XX5	16299	LC6001-4702G

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
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Capacitors

C1	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C2	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C3	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C4	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C5	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C6	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C7	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C8	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C9	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C10	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C11	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C12	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C13	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C14	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C15	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C16	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C17	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C18	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C19	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C20	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C21	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C22	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C23	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C24	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C25	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C26	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C27	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C28	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C29	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C30	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C31	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C32	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C33	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C34	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C35	Not Used			
C36	Not Used			
C37	Not Used			
C38	Not Used			
C39	Not Used			
C40	Not Used			
C41	Not Used			
C42	Not Used			
C43	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C44	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C45	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C46	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C47	Not Used			
C48	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C49	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C50	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C51	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C52	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C53	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
C54	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C55	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C56	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C57	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C58	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C59	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C60	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C61	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10

Diodes

CR1	Rectifier	DIOCR4002XXX	04713	1N4002
CR2	Rectifier	DIOCR4002XXX	04713	1N4002
CR3	Rectifier	DIOCR4002XXX	04713	1N4002
CR4	Rectifier	DIOCR4002XXX	04713	1N4002
CR5	Rectifier	DIOCR4002XXX	04713	1N4002
CR6	Rectifier	DIOCR4002XXX	04713	1N4002
CR7	Rectifier	DIOCR4002XXX	04713	1N4002
CR8	Rectifier	DIOCR4002XXX	04713	1N4002
CR9	Rectifier	DIOCR4002XXX	04713	1N4002
CR10	Rectifier	DIOCR4002XXX	04713	1N4002
CR11	Rectifier	DIOCR4002XXX	04713	1N4002
CR12	Not Used			
CR13	Rectifier	DIOCR4002XXX	04713	1N4002
CR14	Rectifier	DIOCR4002XXX	04713	1N4002
CR15	Rectifier	DIOCR4002XXX	04713	1N4002
CR16	Rectifier	DIOCR4002XXX	04713	1N4002
CR17	Rectifier	DIOCR4002XXX	04713	1N4002
CR18	Rectifier	DIOCR4002XXX	04713	1N4002
CR19	Rectifier	DIOCR4002XXX	04713	1N4002
CR20	Rectifier	DIOCR4002XXX	04713	1N4002
CR21	Rectifier	DIOCR4002XXX	04713	1N4002
CR22	Rectifier	DIOCR4002XXX	04713	1N4002
CR23	Suppressor	DIOTS6R86267	24444	1.5KE6.8
CR24	Rectifier	DIOCR4002XXX	04713	1N4002

Integrated Circuits Digital

IC1	Nand Gate	ICDNANPXL00	27014	74LS00
IC2	Hex Inverter	ICDINVXXX06	27014	7406
IC3	Nand Gate	ICDNANDXLS00	27014	74LS00
IC4	Nand Gate	ICDNANDXLS00	27014	74LS00
IC5	Nand Gate	ICDNANDXLS00	27014	74LS00
IC6	Hex Inverter	ICDINVXXX06	27014	7406
IC7	Nand Gate	ICDNANDXLS00	27014	74LS00
IC8	Nand Gate	ICDNANDXLS00	27014	74LS00
IC9	Nand Gate	ICDNANDXLS00	27014	74LS00
IC10	Hex Inverter	ICDINVXXX06	27014	7406
IC11	Not Used			
IC12	Nand Gate	ICDNANDXLS00	27014	74LS00
IC13	Hex Inverter	ICDINVXXX06	27014	7406
IC14	Nand Gate	ICDNANDXLS00	27014	74LS00
IC15	Hex Inverter	ICDINVXXX06	27014	7406

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
IC16	Hex Inverter	ICDINVXXXX06	27014	7406
IC17	Nand Gate	ICDNANDXLS00	27014	74LS00
IC18	Nand Gate	ICDNANDXLS00	27014	74LS00
IC19	Nand Gate	ICDNANDXLS00	27014	74LS00
IC20	Nand Gate	ICDNANDXLS00	27014	74LS00
IC21	Not Used			
IC22	Nand Gate	ICDNANDXLS00	27014	74LS00
IC23	Nand Gate	ICDNANDXLS00	27014	74LS00
IC24	Nand Gate	ICDNANDXLS00	27014	74LS00
IC25	Nand Gate	ICDNANDXLS00	27014	74LS00
IC26	Nand Gate	ICDNANDXLS00	27014	74LS00
IC27	Nand Gate	ICDNANDXLS00	27014	74LS00
IC28	Nand Gate	ICDNANDXLS00	27014	74LS00
IC29	BCD/DEC Decoder	ICDDECXXLS42	27014	74LS42
IC30	Nand Gate	ICDNANDXLS00	27014	74LS00
IC31	Nand Gate	ICDNANDXLS00	27014	74LS00
IC32	Nand Gate	ICDNANDXLS00	27014	74LS00
IC33	Nand Gate	ICDNANDXLS00	27014	74LS00
IC34	Nand Gate	ICDNANDXLS00	27014	74LS00
IC35	Nand Gate	ICDNANDXLS00	27014	74LS00
IC36	Nand Gate	ICDNANDXLS00	27014	74LS00
IC37	Nand Gate	ICDNANDXLS00	27014	74LS00

Relays

K1	4PDT 1500V	REL4PDTSTDHV	92714	AZ421-70-221
K2	4PDT 1500V	REL4PDTSTDHV	92714	AZ421-70-221
K3	4PDT 1500V	REL4PDTSTDHV	92714	AZ421-70-221
K4	4PDT 1500V	REL4PDTSTDHV	92714	AZ421-70-221
K5	4PDT 1500V	REL4PDTSTDHV	92714	AZ421-70-221
K6	4PDT 1500V	REL4PDTSTDHV	92714	AZ421-70-221
K7	4PDT 1500V	REL4PDTSTDHV	92714	AZ421-70-221
K8	4PDT 1500V	REL4PDTSTDHV	92714	AZ421-70-221

Resistors

R1	WW 1.01	RESPW1R01500	58880	1251
R1A	WW 200	RESPW200X050	58880	1250
R1B	WW Trim			
R1C	WW 100	RESPW100X050	58880	1250
R1D	WW Trim			
R1E	Variable 200	RESVF200XX89	73138	89PR200
R2	WW 10.1	RESPW10R1500	58880	1251
R2A	WW 1K	RESPW1001050	58880	1250
R2B	WW Trim			
R2C	Variable 500	RESVF500XX89	73138	89PR500
R3	WW 101	RESPW101X050	58880	1251
R3A	WW 10K	RESPW1002050	58880	1250
R3B	WW Trim			
R3C	Variable 2K	RESVF2001X89	73138	89PR2K
R4	WW 1K	RESPW1001050	58880	1251
R5	WW 10K	RESPW1002XXX	58880	R2382W/COAT
R6	WW 100K	RESPW1003XXX	58880	R2382W/COAT

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
R7	WW 1M	RESPW1004XXX	58880	R2383W/COAT
R8	PF 10M	RESPF1005050	19647	MS220
R9	MF 100	RESMF100XXXX	16299	SMA-4
R10	MF 100	RESMF100XXXX	16299	SMA-4
R11	MF 100	RESMF100XXXX	16299	SMA-4
R12	MF 100	RESMF100XXXX	16299	SMA-4
R13	MF 100	RESMF100XXXX	16299	SMA-4
R14	MF 100	RESMF100XXXX	16299	SMA-4
R15	MF 100	RESMF100XXXX	16299	SMA-4
R16	MF 100	RESMF100XXXX	16299	SMA-4
R17	MF 5.11K	RESMF5111XXX	16299	SMA-4
R18	MF 5.11K	RESMF5111XXX	16299	SMA-4
R19	MF 5.11K	RESMF5111XXX	16299	SMA-4
R20	MF 5.11K	RESMF5111XXX	16299	SMA-4
R21	MF 5.11K	RESMF5111XXX	16299	SMA-4
R22	MF 5.11K	RESMF5111XXX	16299	SMA-4
R23	MF 5.11K	RESMF5111XXX	16299	SMA-4
R24	MF 100	RESMF100XXXX	16299	SMA-4
R25	MF 100	RESMF100XXXX	16299	SMA-4
R26	MF 100	RESMF100XXXX	16299	SMA-4
R27	Not Used			
R28	MF 100	RESMF100XXXX	16299	SMA-4
R29	MF 100	RESMF100XXXX	16299	SMA-4
R30	MF 100	RESMF100XXXX	16299	SMA-4
R31	MF 100	RESMF100XXXX	16299	SMA-4
R32	MF 100	RESMF100XXXX	16299	SMA-4
R33	MF 100	RESMF100XXXX	16299	SMA-4
R34	MF 100	RESMF100XXXX	16299	SMA-4
R35	MF 100	RESMF100XXXX	16299	SMA-4
R36	MF 100	RESMF100XXXX	16299	SMA-4
R37	Not Used			
R38	MF 51.1K	RESMF5112XXX	16299	SMA-4
R39	MF 100	RESMF100XXX	16299	SMA-4
R40	Not Used			
R41	1K	RESMF1001XXX	16299	SMA-4
R42	1K	RESMF1001XXX	16299	SMA-4
R43	1K	RESMF1001XXX	16299	SMA-4
R44	1K	RESMF1001XXX	16299	SMA-4
R45	1K	RESMF1001XXX	16299	SMA-4
R46	1K	RESMF1001XXX	16299	SMA-4
R47	1K	RESMF1001XXX	16299	SMA-4
R48	1K	RESMF1001XXX	16299	SMA-4
R49	21.5K	RESMF2152XXX	16299	SMA-4
R50	21.5K	RESMF2152XXX	16299	SMA-4
R51	21.5K	RESMF2152XXX	16299	SMA-4
R52	21.5K	RESMF2152XXX	16299	SMA-4
R53	21.5K	RESMF2152XXX	16299	SMA-4
R54	21.5K	RESMF2152XXX	16299	SMA-4
R55	21.5K	RESMF2152XXX	16299	SMA-4
R56	21.5K	RESMF2152XXX	16299	SMA-4
R57	MF 10K	RESMF1002XXX	16299	SMA-4
R58	MF 10K	RESMF1002XXX	16299	SMA-4
R59	MF 10K	RESMF1002XXX	16299	SMA-4
R60	MF 10K	RESMF1002XXX	16299	SMA-4
R61	MF 10K	RESMF1002XXX	16299	SMA-4

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
R62	MF 10K	RESMF1002XXX	16299	SMA-4
R63	MF 10K	RESMF1002XXX	16299	SMA-4
R64	MF 10K	RESMF1002XXX	16299	SMA-4

Transistors

Q1	Signal PNP	TRASPSA55XXX	09212	MPSA55
Q2	Signal PNP	TRASPSA55XXX	09212	MPSA55
Q3	Signal PNP	TRASPSA55XXX	09212	MPSA55
Q4	Signal PNP	TRASPSA55XXX	09212	MPSA55
Q5	Signal PNP	TRASPSA55XXX	09212	MPSA55
Q6	Signal PNP	TRASPSA55XXX	09212	MPSA55
Q7	Signal PNP	TRASPSA55XXX	09212	MPSA55
Q8	Signal PNP	TRASPSA55XXX	09212	MPSA55
Q9	Signal NPN	TRASNSA05XXX	09212	MPSA05
Q10	Signal NPN	TRASNSA05XXX	09212	MPSA05
Q11	Signal NPN	TRASNSA05XXX	09212	MPSA05
Q12	Signal NPN	TRASNSA05XXX	09212	MPSA05
Q13	Signal NPN	TRASNSA05XXX	09212	MPSA05
Q14	Signal NPN	TRASNSA05XXX	09212	MPSA05
Q15	Signal NPN	TRASNSA05XXX	09212	MPSA05
Q16	Signal NPN	TRASNSA05XXX	09212	MPSA05

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
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Integrated Circuits Linear

AR1	Op Amp	ICLAAD518JH	24355	AD518JH
AR2	Op Amp	ICLAAD518JH	24355	AD518JH
AR3	Op Amp	ICLAAD518JH	24355	AD518JH
AR4	Op Amp	ICLOAAD741JN	24355	AD741JN
AR5	Modulator	ICLMODXX1496	24713	LM1496

Capacitors

C1	Not Used			
C2	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C3	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C4	Dipped Mica 47pf	CAPDM47XX500	14655	CD15ED470J03
C5	Polycarb 1.987uf	CAPPC1984050	90670	DL1A19873F-1
C6	Polycarb 0.1962uf	CAPPC1963050	90670	DL1A19622F-1
C7	Polycarb 0.01977uf	CAPPC1972050	90670	DL1A19771F-1
C8	Dipped Mica 330pf	CAPDM330X500	14655	CD15FD331J03
C9	Dipped Mica 1500pf	CAPDM1501500	90670	CD19FD152J03
C10	Dipped Mica 10pf	CAPDM10XX500	14655	CD15CD100J03
C11	Dipped Mica 100pf	CAPDM100X500	14655	CD15FD101J03
C12	Polycarb 1.987uf	CAPPC1984050	90670	DL1A19873F-1
C13	Polycarb 0.1962uf	CAPPC1963050	90670	DL1A19622F-1
C14	Polycarb 0.01977uf	CAPPC1972050	90670	DL1A1977aF-1
C15	Dipped Mica 1500pf	CAPDM1501500	14655	CD19FD152J03
C16	Dipped Mica 330pf	CAPDM330X500	14655	CD15EF331J03
C17	Dipped Mica 100pf	CAPDM100X500	14655	CD15FD101J03
C18	Not Used			
C19	Dipped Mica 22pf	CAPDM22XX500	14655	CD15ED220J03
C20	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C21	Not Used			
C22	Cer. Disc 0.1uf	CAPCD1003050	04222	3429:050E-104M
C23	Dipped Mica 2pf	CAPDM2XXX500	14655	CD15CD0020D03
C24	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C25	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C26	Not Used			
C27	Polycarb 4uf	CAPPC4004050	90670	RA1A405
C28	Al. Elect. 100uf	CAPAL1006035	MAR6116	CEUST1E101
C29	Not Used			
C30	Al. Elect. 47uf	CAPAL4705050	NIC7500	TLB1H470M
C31	Dipped Mica 10pf	CAPDM10XX500	14655	CD15CD100J03
C32	Not Used			
C33	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C34	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C35	Not Used			
C36	Not Used			
C37	Not Used			
C38	Not Used			
C39	Not Used			
C40	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C41	Dipped Mica 22pf	CAPDM22XX500	90670	CM15ED220Jo3
C42	Not Used			
C43	Al. Elect. 100uf	CAPAL1006035	MAR6116	CEUST1E101
C44	Dipped Mica 10pf	CAPDM10XX500	14655	CD15CD100J03
C45	Dipped Mica 22pf	CAPDM22XX500	14655	CM15ED220J03

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
C46	Dipped Mica 220pf	CAPDM220X500	14655	CD15FD221J03
Diodes				
CR1	Signal	DIOCRN914XXX	07263	1N914
Resistors				
R1	MF 1K	RESMF1001XXX	16299	SMA-4
R2	MF 2K	RESMF2001XXX	16299	SMA-4
R3	MF 4.02K	RESMF4021XXX	16299	SMA-4
R4	MF 8.06K	RESMF8061XXX	16299	SMA-4
R5	MF 10K	RESMF1002XXX	16299	SMA-4
R6	MF 20K	RESMF2002XXX	16299	SMA-4
R7	MF 40.2K	RESMF4022XXX	16299	SMA-4
R8	MF 80.6K	RESMF8062XXX	16299	SMA-4
R9	MF 1.47K	RESMF1471XXX	16299	SMA-4
R10	MF 10K	RESMF1002XXX	16299	SMA-4
R11	Not Used			
R12	Not Used			
R13	MF 511	RESMF511XXXX	16299	SMA-4
R14	Not Used			
R15	Not Used			
R16	Not Used			
R17	MF 1K	RESMF1001XXX	16299	SMA-4
R18	MF 1K	RESMF1001XXX	16299	SMA-4
R19	MF 2K	RESMF2001XXX	16299	SMA-4
R20	MF 40.2K	RESMF4021XXX	16299	SMA-4
R21	MF 8.06K	RESMF8061XXX	16299	SMA-4
R22	MF 10K	RESMF	16299	SMA-4
R23	MF 20K	RESMF2002XXX	16299	SMA-4
R24	MF 40.2K	RESMF4022XXX	16299	SMA-4
R25	MF 80.6K	RESMF8062XXX	16299	SMA-4
R26	MF 1K	RESMF1001XXX	16299	SMA-4
R27	Not Used			
R28	MF 511	RESMF511XXXX	16299	SMA-4
R29	Not Used			
R30	Not Used			
R31	Not Used			
R32	MF 511	RESMF511XXXX	16299	SMA-4
R33	MF 5.11K	RESMF5111XXX	16299	SMA-4
R34	MF 5.11K	RESMF5111XXX	16299	SMA-4
R35	Not Used			
R36	Not Used			
R37	Not Used			
R38	MF 3.48K	RESMF3481XXX	16299	SMA-4
R39	Not Used			
R40	Not Used			
R41	Not Used			
R42	Not Used			
R43	Not Used			
R44	Not Used			
R45	MF 681	RESMF681XXXX	16299	SMA-4
R46	MF 1.47K	RESMF1471XXX	16299	SMA-4
R47	MF 3.48K	RESMF3481XXX	16299	SMA-4

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
R48	MF 3.48K	RESMF3481XXX	16299	SMA-4
R49	Not Used			
R50	MF 10K	RESMF1002XXX	16299	SMA-4
R51	MF 51.1	RESMF51R1XXX	16299	SMA-4
R52	MF 6.81K	RESMF6811XXX	16299	SMA-4
R53	MF 511	RESMF511XXXX	16299	SMA-4
R54	Variable 1K	RESVF1001X89	73138	89PR1K
R55	MF 511	RESMF511XXXX	16299	SMA-4
R56	MF 511	RESMF511XXXX	16299	SMA-4
R57	MF 1K	RESMF1001XXX	16299	SMA-4
R58	MF 1K	RESMF1001XXX	16299	SMA-4
R59	MF 21.5K	RESMF2152XXX	16299	SMA-4
R60	MF 51.1	RESMF51R1XXX	16299	SMA-4
R61	MF 6.81K	RESMF6811XXX	16299	SMA-4
R62	Not Used			
R63	MF 10K	RESMF1002XXX	16299	SMA-4
R64	MF 10K	RESMF1002XXX	16299	SMA-4
R65	Variable 10K	RESVF1002X89	73138	89PR10K
R66	Variable 10K	RESVF1002X89	73138	89PR10K
R67	Variable 10K	RESVF1002X89	73138	89PR10K
R68	Variable 10K	RESVF1002X89	73138	89PR10K
R69	Variable 10K	RESVF1002X89	73138	89PR10K
R70	Variable 50K	RESVF5002X89	73138	89PR50K
R71	Variable 50K	RESVF5002X89	73138	89PR50K
R72	Variable 50K	RESVF5002X89	73138	89PR50K
R73	Variable 50K	RESVF5002X89	73138	89PR50K
R74	MF 215K	RESMF2153XXX	16299	SMA-4
R75	MF 511K	RESMF5113XXX	16299	SMA-4
R76	MF 14.7	RESMF14R7XXX	16299	SMA-4
R77	PF 10K	RESPF1002050	18612	S102C
R78	MF 34.8	RESMF34R8XXX	16299	SMA-4
R79	PF 20K	RESPF2002050	18612	S102C
R80	MF 511K	RESMF5113XXX	16299	SMA-4
R81	MF 348K	RESMF3483XXX	16299	SMA-4
R82	MF 68.1	RESMF68R1XXX	16299	SMA-4
R83	PF 40K	RESPF4002050	18612	S102C
R84	MF 511K	RESMF5113XXX	16299	SMA-4
R85	MF 1 Meg	RESMF1004XXX	16299	SMA-4
R86	MF 100	RESMF100XXXX	16299	SMA-4
R87	PF 80K	RESPF8002050	18612	S102C
R88	MF 511K	RESMF5113XXX	16299	SMA-4
R89	MF 1 Meg	RESMF1004XXX	16299	SMA-4
R90	MF 147	RESMF147XXXX	16299	SMA-4
R91	WW 100K	RESPW1003050	58880	1250
R92	MF 511K	RESMF5113XXX	16299	SMA-4
R93	MF 511K	RESMF5113XXX	16299	SMA-4
R94	MF 348	RESMF348XXXX	16299	SMA-4
R95	WW 200K	RESPW2003050	58880	1250
R96	MF 1 Meg	RESMF1004XXX	16299	SMA-4
R97	MF 511K	RESMF5113XXX	16299	SMA-4
R98	MF 681	RESMF681XXXX	16299	SMA-4
R99	WW 400K	RESPW4003050	58880	1250
R100	MF 1 Meg	RESMF1004XXX	16299	SMA-4
R101	MF 1 Meg	RESMF1004XXX	16299	SMA-4
R102	MF 1K	RESMF1001XXX	16299	SMA-4

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
R103	WW 800K	RESPW8003050	58880	1250
R104	MF 1 Meg	RESMF1004XXX	16299	SMA-4
R105	MF 1 Meg	RESMF1004XXX	16299	SMA-4
R106	WW 50K	RESPW5002050	58880	1250
R107	WW 10K	RESPW1002050	58880	1250
R108	WW 20K	RESPW2002050	58880	1250
R109	WW 40K	RESPW4002050	58880	1250
R110	WW 80K	RESPW8002050	58880	1250
R111	WW 500	RESPW500X050	58880	1250
R112	WW 50	RESPW50XX500	58880	1250
R113	MF 14.7	RESMF14R7XXX	16299	SMA-4
R114	MF 14.7	RESMF14R7XXX	16299	SMA-4
R115	WW 1 Meg	RESPW1004050	58880	1252
R116	WW 10K	RESPW1002050	58880	1250
R117	WW 20K	RESPW2002050	58880	1250
R118	WW 40K	RESPW4002050	58880	1250
R119	WW 80K	RESPW8002050	58880	1250
R120	WW 1K	RESPW1001050	58880	1250
R121	WW 20K	RESPW2002050	58880	1250
R122	MF 21.5	RESMF21R5XXX	16299	SMA-4
R123	MF 215K	RESMF2153XXX	16299	SMA-4
R124	MF 215K	RESMF2153XXX	16299	SMA-4
R125	Variable 10K	RESVF1002X89	73138	89PR10K
R126	MF 2.15M	RESMF2154XXX	16299	SMA-4
R127	MF 511K	RESMF5113XXX	16299	SMA-4
R128	MF 51.1	RESMF51R1XXX	16299	SMA-4
R129	CC 1K	RESCC1001XXX		
R130	CC 1.5K	RESCC1501XXX		
R131	MF 34.8K	RESMF3482XXX	16299	SMA-4
R132	MF 34.8K	RESMF3482XXX	16299	SMA-4
R133	MF 5.11K	RESMF5111XXX	16299	SMA-4
R134	MF 3.48K	RESMF3481XXX	16299	SMA-4
R135	MF 1K	RESMF1001XXX	16299	SMA-4

Transistors

Q1	Signal NPN	TRASN3019XXX	07263	2N3019
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Switch Circuits

Special circuits -- See parts listing, page 5-50.

U1	S1BAC1	Elect. Switch
U2	S1BAC1	Elect. Switch
U3	S1BAC1	Elect. Switch
U4	S1BAC2	Elect. Switch
U5	S2B	Elect. Switch
U6	S2B	Elect. Switch
U7	S2B	Elect. Switch
U8	S2B	Elect. Switch
U9	S1BAC1	Elect. Switch
U10	S1BAC1	Elect. Switch
U11	S1BAC1	Elect. Switch

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
U12	S1BAC2	Elect. Switch		
U13	S2B	Elect. Switch		
U14	S2B	Elect. Switch		
U15	S2B	Elect. Switch		
U16	S2B	Elect. Switch		
U17	S2BAC	Elect. Switch		
U18	S2BAC	Elect. Switch		
U19	S2BAC	Elect. Switch		
U20	S2BAC	Elect. Switch		
U21	S2B	Elect. Switch		
U22	S2B	Elect. Switch		
U23	S2BAC	Elect. Switch		
U24	S2BAC	Elect. Switch		
U25	S2BAC	Elect. Switch		
U26	S2BAC	Elect. Switch		
U27	S2B	Elect. Switch		
U28	S2B	Elect. Switch		
U29	S2B	Elect. Switch		
U30	S2BATT	Elect. Switch		
U31	S2BATT	Elect. Switch		
U32	S2BATT	Elect. Switch		
U33	S2BATT	Elect. Switch		
U34	S2BATT	Elect. Switch		
U35	S2BATT	Elect. Switch		
U36	S2BATT	Elect. Switch		
U37	S2BATT	Elect. Switch		
U38	S1BATT	Elect. Switch		
U39	S1BATT	Elect. Switch		
U40	S1BATT	Elect. Switch		
U41	S1BATT	Elect. Switch		
U42	S1BATT	Elect. Switch		
U43	S1BATT	Elect. Switch		
U44	S1BATT	Elect. Switch		
U45	S1BATT	Elect. Switch		

ymbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
Integrated Circuits Linear				
AR1	Op Amp	ICLOAAD518JH	24355	AD518JH
AR2	Op Amp	ICLOACSX7652	32293	ICL7652ITV
AR3	Op Amp	ICLOAAD518JH	24355	AD518JH
AR4	Op Amp	ICLOACSX7652	32293	ICL7652ITV
AR5	Op Amp	ICLOACSX7652	32293	ICL7652ITV
AR6	Op Amp	ICLOALNX07CP	06665	OP-07CP
AR7	Op Amp	ICLOADD741JN	24355	AD741JN
AR8	Op Amp	ICLOACSX7652	32293	ICL7652ITV

Capacitors

C1	Dipped Mica 15pf	CAPDM15XX500	14655	CD15CD150J03
C2	Film 0.01uf	CAPPE1002100	56289	225P10391WD3
C3	Dipped Mica 22pf	CAPDM22XX500	14655	CD15ED220J03
C4	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C5	Dipped Mica 220pf	CAPDM220X500	14655	CD15FD221J03
C6	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C7	Not Used			
C8	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C9	Not Used			
C10	Not Used			
C11	Not Used			
C12	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C13	Film 0.01uf	CAPPE1002100	56289	225P10391WD3
C14	Dipped Mica 15pf	CAPDM15XX500	14655	CD15CD0J03
C15	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C16	Not Used			
C17	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C18	Not Used			
C19	Not Used			
C20	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C21	Polycarb 1uf	CAPPC1004050	90670	RA1A105
C22	Not Used			
C23	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C24	Polycarb 10uf	CAPPC1005050	90670	RA1A106K
C25	Polycarb 2uf	CAPPC2004050	90670	RA1A205
C26	Polycarb 0.47uf	CAPPC4703100	90670	DP2B474K
C27	Film 0.1uf	CAPPE1003100	56289	225P10491WD3
C28	Not Used			
C29	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C30	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C31	Not Used			
C32	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C33	Not Used			
C34	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C35	Not Used			
C36	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C37	Dipped Mica 100pf	CAPDM100X500	14655	CD15FD101J03
C38	Not Used			
C39	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C40	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C41	Not Used			
C42	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
C43	Tantalum 4.7uf	CAPTA4704035	37942	TDC475M035FL
C44	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C45	Not Used			
C46	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C47	Cer. Disc 0.01	CAPCD1002100	56289	TG-S10
C48	Polycarb 10uf	CAPPC1005050	90670	RA1A106K
C49	Dipped Mica 2pf	CAPDM2XXX500	14655	CD15CD020D03
C50	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C51	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C52	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C53	Not Used			
C54	Dipped Mica 22pf	CAPDM22XX500	14655	CD15ED220J03
C55	Dipped Mica 47pf	CAPDM47XX500	14655	CD15ED470J03
C56	Dipped Mica 10pf	CAPDM10XX500	14655	CD15CD100J03
C57	Dipped Mica 10pf	CAPDM10XX500	14655	CD15CD100J03
C58	Dipped Mica 10pf	CAPDM10XX500	14655	CD15CD100J03
C59	Film 0.01uf	CAPPE1002100	56289	225P10391WD3
C60	Polycarb 0.47uf	CAPPC4703100	90670	DP2B474K

Diodes

CR1	Signal	DIOCR2800XXX	28480	5082-2800
CR2	Signal	DIOCR2800XXX	28480	5082-2800
CR3	Signal	DIOCR2800XXX	28480	5082-2800
CR4	Signal	DIOCR2800XXX	28480	5082-2800
CR5	Signal	DIOCRN914XXX	07263	1N914
CR6	Signal	DIOCRN914XXX	07263	1N914
CR7	Signal	DIOCRN914XXX	07263	1N914
CR8	Signal	DIOCRN914XXX	07263	1N914
CR9	Signal	DIOCRN914XXX	07263	1N914
CR10	Signal	DIOCRN914XXX	07263	1N914
CR11	Zener	DIOVR5R15231	07263	1N5231B
CR12	Zener	DIOVR5R15231	07263	1N5231B
CR13	Signal	DIOCRN914XXX	07263	1N914
CR14	Signal	DIOCRN914XXX	07263	1N914
CR15	Signal	DIOCRN914XXX	07263	1N914
CR16	Signal	DIOCRN914XXX	07263	1N914
CR17	Signal	DIOCRN914XXX	07263	1N914
CR18	Signal	DIOCRN914XXX	07263	1N914
CR19	Signal	DIOCRN914XXX	07263	1N914
CR20	Signal	DIOCRN914XXX	07263	1N914
CR21	Not Used			
CR22	Not Used			
CR23	Signal	DIOCRN914XXX	07263	1N914
CR24	Signal	DIOCRN914XXX	07263	1N914
CR25	Rectifier	DIOCR4002XXX	04713	1N4002
CR26	Rectifier	DIOCR4002XXX	04713	1N4002
CR27	Rectifier	DIOCR4002XXX	04713	1N4002
CR28	Signal	DIOCRN914XXX	07263	1N914
CR29	Zener	DIOVR5R15231	07263	1N5231B
CR30	Signal	DIOCRN914XXX	07263	1N914
CR31	Zener	DIOVR5R15231	07263	1N5231B
CR32	Signal	DIOCRN914XXX	07263	1N914
CR33	Zener	DIOVR5R15231	07263	1N5231B
CR34	Signal	DIOCRN914XXX	07263	1N914

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
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CR35	Signal	DIOCRN914XXX	07263	1N914
CR36	Zener	DIOVR5R15231	07263	1N5231B
CR37	Zener	DIOVR5R15231	07263	1N5231B

Integrated Circuits Digital

IC1	Nand Gate	ICDNANDXLS00	27014	74LS00
IC2	Nand Gate	ICDNANDXLS00	27014	74LS00
IC3	Not Used			
IC4	Analog Switch	ICLASSP201GP	06665	SW201GP
IC5	Multiplexer	ICDMPXRLS157	02195	74LS157
IC6	Multiplexer	ICDMPXRLS157	02195	74LS157
IC7	Analog Switch	ICLASSP201GP	06665	SW201GP
IC8	Analog Switch	ICLASSP201GP	06665	SW201GP
IC9	Analog Switch	ICLASSP201GP	06665	SW201GP

Relays

K1	2PDT 1500V	REL2PDTSTDHV	92714	AZ-420-70-219
K2	2PDT 1500V	REL2PDTSTDHV	92714	AZ-420-70-219
K3	2PDT 1500V	REL2PDTSTDHV	92714	AZ-420-70-219

Transistors

Q1	Signal	TRASNSA05XXX	09212	MPSA05
Q2	Not Used			
Q3	Signal NPN	TRASN3019XXX	07263	2N3019
Q4	Signal NPN	TRASN3019XXX	07263	2N3019

Resistors

R1	PF 5K	RESPF5001050	18612	S102C
R2	PF 5K	RESPF5001050	18612	S102C
R3	MF 5.11K	RESMF5111XXX	16299	SMA-4
R4	MF 10K	RESMF1002XXX	16299	SMA-4
R5	MF 511	RESMF511XXXX	16299	SMA-4
R6	MF 511	RESMF511XXXX	16299	SMA-4
R7	MF 34.8K	RESMF3482XXX	16299	SMA-4
R8	MF 14.7K	RESMF1472XXX	16299	SMA-4
R9	MF 100	RESMF100XXXX	16299	SMA-4
R10	MF 34.8K	RESMF3482XXX	16299	SMA-4
R11	MF 1.47K	RESMF1471XXX	16299	SMA-4
R12	MF 34.8K	RESMF3482XXX	16299	SMA-4
R13	MF 1K	RESMF1001XXX	16299	SMA-4
R14	MF 1.47K	RESMF1471XXX	16299	SMA-4
R15	MF 1.47K	RESMF1471XXX	16299	SMA-4
R16	MF 1.47K	RESMF1471XXX	16299	SMA-4
R17	MF 100	RESMF100XXXX	16299	SMA-4
R18	MF 511	RESMF511XXXX	16299	SMA-4
R19	MF 100K	RESMF1003XXX	16299	SMA-4
R20	MF 100K	RESMF1003XXX	16299	SMA-4
R21	MF 100K	RESMF1003XXX	16299	SMA-4
R22	MF 348K	RESMF3483XXX	16299	SMA-4
R23	MF 348K	RESMF3483XXX	16299	SMA-4
R24	Not Used			

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
R25	MF 147K	RESMF1473XXX	16299	SMA-4
R26	PF 8K	RESPF8001050	18612	S102C
R27	MF 14.7	RESMF14R7XXX	16299	SMA-4
R28	MF 100K	RESMF1003XXX	16299	SMA-4
R29	MF 215K	RESMF2153XXX	RESMF	SMA-4
R30	Variable 10K	RESVF1002X89	73138	89PR10K
R31	MF 6.81K	RESMF6811XXX	16299	SMA-4
R32	MF 215	RESMF215XXXX	16299	SMA-4
R33	MF 5.11K	RESMF5111XXX	16299	SMA-4
R34	MF 3.48K	RESMF3481XXX	16299	SMA-4
R35	MF 1K	RESMF1001XXX	16299	SMA-4
R36	MF 10K	RESMF1002XXX	16299	SMA-4
R37	MF 100K	RESMF1003XXX	16299	SMA-4
R38	MF 21.5K	RESMF2152XXX	16299	SMA-4
R39	MF 100K	RESMF1003XXX	16299	SMA-4
R40	MF 100K	RESMF1003XXX	16299	SMA-4
R41	MF 681K	RESMF6813XXX	16299	SMA-4
R42	Variable 10K	RESVF1002X89	73138	89PR10K
R43	MF 51.1K	RESMF5112XXX	16299	SMA-4
R44	MF 10K	RESMF1002XXX	16299	SMA-4
R45	MF 21.5	RESMF21R5XXX	16299	SMA-4
R46	MF 34.8	RESMF34R8XXX	16299	SMA-4
R47	PF 200	RESPF200X050	18612	S102C
R48	MF 3.48	RESMF3483XXX	16299	SMA-4
R49	PF 2K	RESPF2001050	18612	S102C
R50	MF 511	RESMF511XXXX	16299	SMA-4
R51	MF 34.8K	RESMF3482XXX	16299	SMA-4
R52	MF 511	RESMF511XXXX	16299	SMA-4
R53	MF 34.8K	RESMF3482XXX	16299	SMA-4
R54	MF 147K	RESMF1473XXX	16299	SMA-4
R55	MF 100	RESMF100XXXX	16299	SMA-4
R56	MF 34.8K	RESMF3482XXX	16299	SMA-4
R57	MF 681K	RESMF6813XXX	16299	SMA-4
R58	MF 511	RESMF511XXXX	16299	SMA-4
R59	MF 100	RESMF100XXXX	16299	SMA-4
R60	MF 14.7	RESMF14R7XXX	16299	SMA-4
R61	MF 1K	RESMF1001XXX	16299	SMA-4
R62	MF 348	RESMF348XXXX	16299	SMA-4
R63	MF 100K	RESMF1003XXX	16299	SMA-4
R64	MF 100K	RESMF1003XXX	16299	SMA-4
R65	MF 100K	RESMF1003XXX	16299	SMA-4
R66	MF 51.1K	RESMF5112XXX	16299	SMA-4
R67	MF 348K	RESMF3483XXX	16299	SMA-4
R68	MF 147K	RESMF1473XXX	16299	SMA-4
R69	MF 681K	RESMF6813XXX	16299	SMA-4
R70	MF 1 Meg	RESMF1004XXX	16299	SMA-4
R71	MF 1K	RESMF1001XXX	16299	SMA-4
R72	WW 200	RESPW200X050	58880	1250
R73	WW 200	RESPW200X050	58880	1250
R74	WW 10K	RESPW1002050	58880	1250
R75	MF 1.47K	RESMF1471XXX	16299	SMA-4
R76	MF 5.11K	RESMF5111XXX	16299	SMA-4
R77	MF 1.47K	RESMF1471XXX	16299	SMA-4
R78	MF 5.11K	RESMF5111XXX	16299	SMA-4
R79	MF 215	RESMF215XXXX	16299	SMA-4

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
R80	WW 20K	RESPW2002050	58880	1250
R81	WW 50K	RESPW5002050	58880	1250
R82	WW 100K	RESPW1003050	58880	1250
R83	MF 1 Meg	RESMF1004XXX	16299	SMA-4
R84	MF 100	RESMF100XXXX	16299	SMA-4
R85	MF 14.7K	RESMF1472XXX	16299	SMA-4
R86	CF 3.3 Meg	RESCF3304XXX	80031	5021GL3M300F
R87	MF 68.1	RESMF68R1XXX	16299	SMA-4
R88	MF 14.7K	RESMF1472XXX	16299	SMA-4
R89	MF 100K	RESMF1003XXX	16299	SMA-4
R90	WW 10K	RESPW1002050	58880	1250
R91	WW 10K	RESPW1002050	58880	1250
R92	MF 511	RESMF511XXXX	16299	SMA-4
R93	MF 1K	RESMF1001XXX	16299	SMA-4
R94	MF 5.11K	RESMF5111XXX	16299	SMA-4
R95	WW Trim			
R96	WW Trim			
R97	WW Trim			
R98	WW Trim			
R99	WW 5K	RESPW5001050	58880	1250
R100	MF 100K	RESMF1003XXX	16299	SMA-4
R101	MF 1.47K	RESMF1471XXX	16299	SMA-4
R102	Variable 10K	RESVF1002X89	73138	89PR10K
R103	MF 215K	RESMF2153XXX	16299	SMA-4
R104	MF 100K	RESMF1003XXX	16299	SMA-4
R105	MF 1.47K	RESMF1471XXX	16299	SMA-4
R106	MF 5.11K	RESMF5111XXX	16299	SMA-4
R107	MF 5.11K	RESMF5111XXX	16299	SMA-4
R108	MF 215	RESMF215XXXX	16299	SMA-4
R109	MF 10K	RESMF1002XXX	16299	SMA-4
R110	WW 8K	RESPW8001050	58880	1250
R111	WW 80K	RESPW8002XXX	58880	1250
R112	WW 800K	RESPW8003XXX	58880	1251
R113	MF 8 Meg	RESMF8004XXX	80031	5053YL8M000F
R114	WW 400K	RESPW4003050	58880	1251
R115	WW 500	RESPW500X050	58880	1250
R116	WW 500	RESPW500X050	58880	1250
R116A	WW 500	RESPW500X050	58880	1250
R117	MF 1K	RESMF1001XXX	16299	SMA-4
R118	MF 1K	RESMF1001XXX	16299	SMA-4
R119	MF 2.15K	RESMF2151XXX	16299	SMA-4
R120	MF 147	RESMF147XXXX	16299	SMA-4
R121	CF 18 Meg	RESCF1805XXX	80031	
R122	MF 100	RESMF100XXXX	16299	SMA-4
R123	MF 100	RESMF100XXXX	16299	SMA-4
R124	MF 100	RESMF100XXXX	16299	SMA-4
R125	MF 2.15K	RESMF2151XXX	16299	SMA-4
R126	Not Used			
R127	MF 681	RESMF681XXXX	16299	SMA-4
R128	MF 681	RESMF681XXXX	16299	SMA-4
R129	MF 10K	RESMF1002XXX	16299	SMA-4

Precision Diode

RX1	Reference Assy	DIOPR8R0399X	27014	LM399AH
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Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
Resistor Networks				
RU1	6 Pin SIP 47K	RESS14702XX5	16299	LC6001-4702G
RU2	6 Pin SIP 47K	RESS14702XX5	16299	LC6001-4702G
RU3	6 Pin SIP 47K	RESS14702XX5	16299	LC6001-4702G
RU4	6 Pin SIP 47K	RESS14702XX5	16299	LC6001-4702G

Special Circuits

Special circuits - See parts listing, page 5-50.

U1	S2B	Switch Circuit
U2	S2B	Switch Circuit
U3	S2B	Switch Circuit
U4	S2B	Switch Circuit
U5	S2B	Switch Circuit
U6	S2B	Switch Circuit
U7	S4	Switch Circuit
U8	S4	Switch Circuit
U9	S4	Switch Circuit
U10	S4	Switch Circuit
U11	Not Used	
U12	Not Used	
U13	Not Used	
U14	S2B	Switch Circuit

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
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Integrated Circuits Linear

AR1	Op Amp	ICLOAAD518JH	24355	AD518JH
AR2	Op Amp	ICLOAAD518JH	24355	AD518JH
AR3	Op Amp	ICLOACSX7652	32292	ICL7650ITV
AR4	Op Amp	ICLOALNX37FJ	24355	OP-37FJ
AR5	Op Amp	ICLOACSX7652	32293	ICL7652ITV
AR6	Op Amp	ICLOAAD741LN	24355	AD741LN
AR7	Op Amp	ICLOAAD741LN	24355	AD741LN
AR8	Op Amp	ICLOAAD301AN	24355	AD301AN
AR9	Op Amp	ICLOAAD518JH	24355	AD518JH

Capacitors

C1	Dipped Mica 10pf	CAPDM10XX500	14655	CD15CD100J03
C2	Dipped Mica 22pf	CAPDM22XX500	14655	CD15ED220J03
C3	Dipped Mica 470pf	CAPDM470X500	14655	CD15FD471J03
C4	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C5	Dipped Mica 22pf	CAPDM22XX500	14655	CD15ED220J03
C6	Film 0.01uf	CAPPE1002100	56289	225P10391WD3
C7	Not Used			
C8	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C9	Not Used			
C10	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C11	Not Used			
C12	Dipped Mica 220pf	CAPDM220X500	14655	CD15ED220J03
C13	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C14	Cer. Disc 0.1uf	CAPCD1003050	04222	04222
C15	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C16	Polycarb luf	CAPPC1004050	90670	RA1A105
C17	Dipped Mica 100pf	CAPDM100X500	14655	CD15FD101J03
C18	Tantalum 4.7uf	CAPTA4704035	37942	TDC475M035FL
C19	Not Used			
C20	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C21	Tantalum 4.7uf	CAPTA4704035	37942	TDC475M035FL
C22	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C23	Not Used			
C24	Not Used			
C25	Not Used			
C26	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C27	Not Used			
C28	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C29	Dipped Mica Trim			
C30	Dipped Mica 47pf	CAPDM47XX500	14655	CD15ED470J03
C31	Not Used			
C32	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C33	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C34	Not Used			
C35	Not Used			
C36	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C37	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C38	Not Used			
C39	Dipped Mica Trim			
C40	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C41	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
C42	Dipped Mica 33pf	CAPDM33XX500	14655	CD15ED330J03
C43	Not Used			
C44	Cer. Disc .01uf	CAPCD1003050	04222	3429-050E-104M
C45	Dipped Mica 10pf	CAPDM10XX500	14655	CD15CD100J03
C46	Dipped Mica 22pf	CAPDM22XX500	14655	CD15ED220J03
C47	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C48	Not Used			
C49	Cer. Disc 0.1uf	CAPCD1003050	04222	3429-050E-104M
C50	Not Used			
C51	Not Used			
C52	Dipped Mica 150pf	CAPDM150X500	14655	CD15FD151J03
C53	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C54	Al. Elect. 47uf	CAPAL4705050	NIC7500	TLB1H470M
C55	Not Used			
C56	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C57	Al. Elect. 47uf	CAPAL4705050	NIC7500	TLB1H470M
C58	Dipped Mica Trim			
C59	Not Used			
C60	Dipped Mica 22pf	CAPDM22XX500	14655	CD15ED220J03
C61	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C62	Tantalum 22uf	CAPTA2205035	56289	196D226X0035
C63	Tantalum 22uf	CAPTA2205035	56289	196D226X0035
C64	Dipped Mica 15pf	CAPDM15XX500	14655	CD15ED150J03
C65	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C66	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C67	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C68	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C69	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C70	Dipped Mica 10pf	CAPDM10XX500	14655	CD15CD100J03
C71	Dipped Mica 22pf	CAPDM22XX500	14655	CD15ED220J03
C72	Not Used			
C73	Not Used			
C74	Not Used			
C75	Dipped Mica Trim			
C76	Dipped Mica 2200pf	CAPDM2201500	14655	CD19FD222J03
C77	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C78	Not Used			
C79	Not Used			
C80	Not Used			
C81	Dipped Mica 2pf	CAPDM2XXX500	14655	CD15CD020D03
C82	Polycarb 10uf	CAPPC1005050	90670	RA1A106K
C83	Dipped Mica 33pf	CAPDM33XX500	14655	CD15ED330J03
C84	Not Used			
C85	Dipped Mica 220pf	CAPDM220X500	14655	CD15FD221J03
C86	Not Used			
C87	Dipped Mica 2pf	CAPDM2XXX500	14655	CD15CD020D03
C88	Dipped Mica 220pf	CAPDM220X500	14655	CD15FD221J03
C89	Not Used			
C90	Not Used			
C91	Not Used			
C92	Not Used			
C93	Dipped Mica 15pf	CAPDM15XX500	14655	CD15ED150J03
C94	Not Used			
C95	Dipped Mica 150pf	CAPDM150X500	14655	CD15FD151J03

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
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Diodes

CR1	Signal	DIOCRN914XXX	07263	1N914
CR2	Signal	DIOCRN914XXX	07263	1N914
CR3	Signal	DIOCRN914XXX	07263	1N914
CR4	Zener	DIOVR5R15231	07263	1N5231B
CR5	Zener	DIOVR5R15231	07263	1N5231B
CR6	Not Used			
CR7	Not Used			
CR8	Zener	DIOVR5R15231	07263	1N5231B
CR9	Zener	DIOVR5R15231	07263	1N5231B
CR10	Signal	DIOCRN914XXX	07263	1N914
CR11	Signal	DIOCRN914XXX	07263	1N914
CR12	Signal	DIOCRN914XXX	07263	1N914
CR13	Signal	DIOCRN914XXX	07263	1N914
CR14	Not Used			
CR15	Not Used			
CR16	Signal	DIOCRN914XXX	07263	1N914
CR17	Signal	DIOCRN914XXX	07263	1N914
CR18	Signal	DIOCRN914XXX	07263	1N914
CR19	Signal	DIOCRN914XXX	07263	1N914
CR20	Signal	DIOCRN914XXX	07263	1N914
CR21	Signal	DIOCRN914XXX	07263	1N914
CR22	Signal	DIOCRN914XXX	07263	1N914
CR23	Signal	DIOCRN914XXX	07263	1N914
CR24	Zener	DIOVR5R15231	07263	1N5231B
CR25	Zener	DIOVR5R15231	07263	1N5231B
CR26	Zener	DIOVR5R15231	07263	1N5231B
CR27	Rectifier	DIOCR4002XXX	04713	1N4002
CR28	Rectifier	DIOCR4002XXX	04713	1N4002
CR29	Rectifier	DIOCR4002XXX	04713	1N4002
CR30	Rectifier	DIOCR4002XXX	04713	1N4002
CR31	Rectifier	DIOCR4002XXX	04713	1N4002
CR32	Rectifier	DIOCR4002XXX	04713	1N4002
CR33	Zener	DIOVR5R15231	07263	1N5231B
CR34	Not Used			
CR35	Signal	DIOCRN914XXX	07263	1N914
CR36	Signal	DIOCRN914XXX	07263	1N914
CR37	Rectifier	DIOCR4002XXX	04713	1N4002
CR38	Rectifier	DIOCR4002XXX	04713	1N4002
CR39	Not Used			
CR40	Zener	DIOVR5R15231	07263	1N5231
CR41	Zener	DIOVR5R15231	07263	1N5231

Relays

K1	2PDT 1500V	REL2DPTSTDHV	92714	AZ420-70-220
K2	2PDT 1500V	REL2DPTSTDHV	92714	AZ420-70-220
K3	2PDT 1500V	REL2DPTSTDHV	92714	AZ420-70-220
K4	2PDT 1500V	REL2DPTSTDHV	92714	AZ420-70-220
K5	2PDT 1500V	REL2DPTSTDHV	92714	AZ420-70-220
K6	2PDT 1500V	REL2DPTSTDHV	92714	AZ420-70-220
K7	4PDT 1500V	REL4DPTSTDHV	92714	AZ421-70-221
K8	2PDT 1500V	REL2DPTSTDHV	92714	AZ420-70-220
K9	2PDT 1500V	REL2DPTSTDHV	92714	AZ420-70-220

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
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Integrated Circuits Digital

IC1	Switch	ICLASSP201GP	06665	SW201GP
IC2	Nand Gate	ICDNANDXLS00	27014	74LS00N

Inductors

L1	luhy	IND1UHXXXXXX	00213	RFC-L1UY
L2	50mhy	IND50MHXXXXX	04213	1662-4

Transistors

Q1	Dual NPN	TRASN2060XXX	07933	2N2060
Q2	Part of Q1			
Q3	Signal NPN	TRASN3019XXX	07263	2N3019
Q4	Signal NPN	TRASN3019XXX	07263	2N3019
Q5	Signal PNP	TRASN4033XXX	07263	2N4033

Resistors

R1	MF 3.48K	RESMF3481XXX	16299	SMA-4
R2	Not Used			
R3	MF 10K	RESMF1002XXX	16299	SMA-4
R4	MF 14.7K	RESMF1472XXX	16299	SMA-4
R5	MF 100K	RESMF1003XXX	16299	SMA-4
R6	MF 14.7K	RESMF1472XXX	16299	SMA-4
R7	MF 100K	RESMF1003XXX	16299	SMA-4
R8	MF 5.11K	RESMF5111XXX	16299	SMA-4
R9	Not Used			
R10	Not Used			
R11	Not Used			
R12	MF 215K	RESMF2153XXX	16299	SMA-4
R13	PF 8K	RESPF8001050		
R14	MF 14.7	RESMF14R7XXX	16299	SMA-4
R15	MF 511	RESMF511XXXX	16299	SMA-4
R16	MF 34.8K	RESMF3482XXX	16299	SMA-4
R17	MF 511	RESMF511XXXX	16299	SMA-4
R18	MF 34.8K	RESMF3482XXX	16299	SMA-4
R19	Not Used			
R20	MF 100	RESMF100XXXX	16299	SMA-4
R21	MF 34.8K	RESMF3482XXX	16299	SMA-4
R22	Not Used			
R23	MF 100K	RESMF1003XXX	16299	SMA-4
R24	Variable 10K	RESVF1002X89	73138	89PR10K
R25	PF 8K	RESPF8001050		
R26	MF 511K	RESMF5113XXX	16299	SMA-4
R27	Variable 10K	RESVF1002X89	73138	89PR10K
R28	MF 511K	RESMF5113XXX	16299	SMA-4
R29	MF 1 Meg	RESMF1004XXX	16299	SMA-4
R30	MF 1K	RESMF1001XXX	16299	SMA-4
R31	MF 1.47K	RESMF1471XXX	16299	SMA-4
R32	Not Used			
R33	MF 1.47K	RESMF1471XXX	16299	SMA-4
R34	MF 1.47K	RESMF1471XXX	16299	SMA-4
R35	MF 1K	RESMF1001XXX	16299	SMA-4

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
R36	MF 1K	RESMF1001XXX	16299	SMA-4
R37	MF 100	RESMF100XXXX	16299	SMA-4
R38	MF 511	RESMF511XXXX	16299	SMA-4
R39	PF 5K	RESPF5001050	18612	SI02C
R40	Not Used			
R41	MF 511	RESMF511XXXX	16299	SMA-4
R42	MF 34.8K	RESMF3482XXX	16299	SMA-4
R43	Not Used			
R44	MF 511K	RESMF5113XXX	16299	SMA-4
R45	MF 348	RESMF348XXXX	16299	SMA-4
R46	Not Used			
R47	MF 511K	RESMF5113XXX	16299	SMA-4
R48	MF 511	RESMF511XXXX	16299	SMA-4
R49	MF 100	RESMF100XXXX	16299	SMA-4
R50	Variable 10K	RESVF1002X89	73138	89PR10K
R51	MF 215K	RESMF2153XXX	16299	SMA-4
R52	MF 1K	RESMF1001XXX	16299	SMA-4
R53	MF 1K	RESMF1001XXX	16299	SMA-4
R54	MF 1K	RESMF1001XXX	16299	SMA-4
R55	MF 1K	RESMF1001XXX	16299	SMA-4
R56	MF 1 Meg	RESMF1004XXX	16299	SMA-4
R57	Variable 10K	RESVF1002X89	73138	89PR10K
R58	MF 511K	RESMF5113XXX	16299	SMA-4
R59	MF 511K	RESMF5113XXX	16299	SMA-4
R60	WW 5K	RESPW5001050	58880	1250
R61	WW 500	RESPW500X050	58880	1250
R62	MF 51.1	RESMF51R1XXX	16299	SMA-4
R63	MF 10	RESMF10R0XXX	16299	SMA-4
R64	MF 100K	RESMF1003XXX	16299	SMA-4
R65	Variable 10K	RESVF1002X89	73138	89PR10K
R66	MF 215K	RESMF2153XXX	16299	SMA-4
R67	WW 5K	RESPW5001050	58880	1250
R68	WW 500	RESPW500X050	58880	1250
R69	MF 51.1	RESMF51R1XXX	16299	SMA-4
R70	MF 10	RESMF10R0XXX	16299	SMA-4
R71	MF 100K	RESMF1003XXX	16299	SMA-4
R72	Variable 10K	RESVF1002X89	73138	89PR10K
R73	MF 215K	RESMF2153XXX	16299	SMA-4
R74	MF 51.1K	RESMF5112XXX	16299	SMA-4
R75	MF 1K	RESMF1001XXX	16299	SMA-4
R76	MF 1K	RESMF1001XXX	16299	SMA-4
R77	Variable 10K	RESVF1002X89	73138	89PR10K
R78	MF 51.1K	RESMF5112XXX	16299	SMA-4
R79	MF 511K	RESMF5113XXX	16299	SMA-4
R80	WW 10K	RESWW1002050	58880	1250
R81	MF 1.47K	RESMF1471XXX	16299	SMA-4
R82	MF 1.47K	RESMF1471XXX	16299	SMA-4
R83	MF 5.11K	RESMF5111XXX	16299	SMA-4
R84	WW 10K	RESPW1002050	58880	1250
R85	Not Used			
R86	Not Used			
R87	MF 1K	RESMF1001XXX	16299	SMA-4
R88	Not Used			
R89	MF 10K	RESMF1002XXX	16299	SMA-4
R90	Not Used			

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
R91	MF 14.7K	RESMF1472XXX	16299	SMA-4
R92	MF 100K	RESMF1003XXX	16299	SMA-4
R93	MF 10K	RESMF1002XXX	16299	SMA-4
R94	MF 1K	RESMF1001XXX	16299	SMA-4
R95	MF 100	RESMF100XXXX	16299	SMA-4
R96	MF 10	RESMF10R0XXX	16299	SMA-4
R97	WW 500K	RESPW5003050	58880	1250
R98	WW 50K	RESPW5002050	58880	1250
R99	WW 5K	RESPW5001010	58880	1250
R100	MF 1K	RESMF1001XXX	16299	SMA-4
R101	Not Used			
R102	WW 500	RESPW500X050	58880	1250
R103	MF 100K	RESMF1003XXX	16299	SMA-4
R104	Variable 50K	RESVF5002X89	73138	89PR50K
R105	WW 1	RESPW1XXX500	58880	1250
R106	MF 2.15K	RESMF2151XXX	16299	SMA-4
R107	Power 50	RESHP50XXXX5	91637	RH-5-19
R108	Variable 1K	RESVF1001X89	73138	89PR1K
R109	MF 348	RESMF348XXXX	16299	SMA-4
R110	Variable 1K	RESVF1001X89	73138	89PR1K
R111	Not Used			
R112	MF 511	RESMF511XXXX	16299	SMA-4
R113	WW 1	RESPW1XXX500	58880	1250
R114	MF 5.11K	RESMF5111XXX	16299	SMA-4
R115	MF 5.11K	RESMF5111XXX	16299	SMA-4
R116	Not Used			
R117	MF 215	RESMF215XXXX	16299	SMA-4
R118	Not Used			
R119	MF 3.48K	RESMF3481XXX	16299	SMA-4
R120	Not Used			
R121	Not Used			
R122	MF 51.1K	RESMF5112XXX	16299	SMA-4
R123	MF 3.48K	RESMF3481XXX	16299	SMA-4
R124	CC 220	RESCC220XXXX	01121	HB2215
R125	MF 10K	RESMF1002XXX	16299	SMA-4
R126	MF 10K	RESMF1002XXX	16299	SMA-4
R127	CC 220	RESCC220XXXX	01121	HB2215
R128	MF 511	RESMF511XXXX	16299	SMA-4
R129	MF 2.15K	RESMF2151XXX	16299	SMA-4
R130	MF 681	RESMF681XXXX	16299	SMA-4
R131	CC 220	RESCC220XXXX	01121	HB2215
R132	CC 150	RESCC150XXXX	01121	HB1515
R133	Variable 10K	RESVF1002X89	73138	89PR10K
R134	MF 21.5K	RESMF2152XXX	16299	SMA-4
R135	MF 1K	RESMF1001XXX	16299	SMA-4
R136	Not Used			
R137	MF 21.5K	RESMF2152XXX	16299	SMA-4
R138	Not Used			
R139	MF 10	RESMF10R0XXX	16299	SMA-4
R140	MF 10	RESMF10R0XXX	16299	SMA-4
R141	CC 150	RESCC150XXXX	01121	HB1515
R142	CC 150	RESCC150XXXX	01121	HB1515
R143	MF 215	RESMF215XXXX	16299	SMA-4
R144	MF 100	RESMF100XXXX	16299	SMA-4
R145	MF 100	RESMF100XXXX	16299	SMA-4

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
R146	MF 100	RESMF100XXXX	16299	SMA-4
R147	MF 100	RESMF100XXXX	16299	SMA-4
R148	MF 100	RESMF100XXXX	16299	SMA-4
R149	WW 1	RESPWLXXX500	58880	1250
R150	MF 21.5K	RESMF2152XXX	16299	SMA-4
R151	CF 3.3 Meg	RESCF3304XXX	8780031	5021GL3M300F
R152	MF 100	RESMF100XXXX	16299	SMA-4
R153	MF 34.8K	RESMF3482XXX	16299	SMA-4
R154	MF 215	RESMF215XXXX	16299	SMA-4
R155	MF 348	RESMF348XXXX	16299	SMA-4
R156	MF 1K	RESMF1001XXX	16299	SMA-4
R157	MF 1K	RESMF1001XXX	16299	SMA-4

Special Circuits

Special Circuits - See parts list, page 5-50.

U1	S2B	Switch Circuit
U2	S2B	Switch Circuit
U3	S2B	Switch Circuit
U4	S2B	Switch Circuit
U5	S4	Switch Circuit
U6	S4	Switch Circuit
U7	S2B	Switch Circuit
U8	S4	Switch Circuit
U9	S2B	Switch Circuit
U10	S2B	Switch Circuit
U11	S2B	Switch Circuit
U12	Not Used	
U13	S2B	Switch Circuit
U14	S2B	Switch Circuit
U15	Not Used	
U16	Not Used	
U17	S4	Switch Circuit
U18	S4	Switch Circuit

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
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Capacitors

C1	Dipped Mica Trim			
C2	Variable 0.8-18pf	CAPVG18XX10C	56289	GGL18000
C3	Dipped Mica 22pf	CAPDM22XX500	14655	CD15ED220J03
C4	Dipped Mica 22pf	CAPDM22XX500	14655	CD15ED220J03
C5	Dipped Mica 22pf	CAPDM22XX500	14655	CD15ED220J03
C6	Dipped Mica 22pf	CAPDM22XX500	14655	CD15ED220J03
C7	Variable 0.8-18pf	CAPVG18XX10C	56289	GGL18000
C8	High Voltage .05uf	CAPHV500220C	99120	LQ20-503Y
C9	Dipped Mica 22pf	CAPDM22CC500	14655	CD15ED220J03
C10	Not Used			
C11	High Voltage .1uf	CAPHV100320C	99120	LQ20-104Y
C12	Not Used			
C13	Not Used			
C14	Dipped Mica 680pf	CAPDM680X500	14655	CD19FD681J03
C15	Variable 0.8-18pf	CAPVG18XX10C	56289	GGL18000

Diodes

CR1	High Voltage	DIOHVV400XXX	83701	EH-400
CR2	High Voltage	DIOHVV400XXX	83701	EH-400
CR3	High Voltage	DIOHVV400XXX	83701	EH-400
CR4	High Voltage	DIOHVV400XXX	83701	EH-400
CR5	Signal	DIOCRN914XXX	07263	1N914
CR6	Signal	DIOCRN914XXX	07263	1N914

Relays

K1	2PDT 1500V	REL2PDTSTDHV	92714	AZ420-70-219
K2	4PDT 1500V	REL4PDTSTDHV	92714	AZ421-70-220
K3	4PDT 1500V	REL4PDTSTDHV	92714	AZ421-70-220
K4	Not Used			
K5	Not Used			
K6	2PDT 1500V	REL2PDTSTDHV	92714	AZ420-70-219
K7	2PDT 1500V	REL2PDTSTDHV	92714	AZ420-70-219
K8	2PDT 1500V	REL2PDTSTDHV	92714	AZ420-70-219
K9	2PDT 1500V	REL2PDTSTDHV	92714	AZ420-70-219
K10	Not Used			
K11	4PDT 1500V	REL4PDTSTDHV	92714	AZ421-70-220
K12	4PDT 1500V	REL4PDTSTDHV	92714	AZ421-70-220
K13	2PDT 1500V	REL2PDTSTDHV	92714	AZ420-70-219
K14	4PDT 1500V	REL4PDTSTDHV	92714	AZ421-70-220
K15	4PDT 1500V	REL4PDTSTDHV	92714	AZ421-70-220
K16	2PDT 1500V	REL2PDTSTDHV	92714	AZ420-70-219

Inductors

L1	0.1hy	IND.1HYXXXXXX	76493	70F101AF
L2	35hy	IND35HYXXXXXX	80089	C2346

Resistors

R1	WW 500K	RESPW5003XXX	54294	HR36M5
R2	WW 500K	RESPW5003XXX	54294	HR36M5

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
R3	MF 1 Meg	RESMF1004XXX	16299	SMA-4
R4	MF 1 Meg	RESMF1004XXX	16299	SMA-4
R5	MF 1 Meg	RESMF1004XXX	16299	SMA-4
R6	Variable 10K	RESVF1002X89	73138	89PR10K
R7	MF 1 Meg	RESMF1004XXX	16299	SMA-4
R8	PF 50K	RESPF5002050	18612	S102C
R8A	PF 50K	RESPF5002050	18612	S102C
R9	MF 1.47K	RESMF1471XXX	16299	SMA-4
R10	MF 100	RESMF100XXXX	16299	SMA-4
R11	MF 1 Meg	RESMF1004XXX	16299	SMA-4
R12	Variable 10K	RESVF1002X89	73138	89PR10K
R13	MF 215K	RESMF2153XXX	16299	SMA-4
R14	PF 8K	RESPF8001050	18612	S102C
R15	WW 800	RESPW800X050	58880	1250
R16	MF 100K	RESMF1003XXX	16299	SMA-4
R17	Variable 10K	RESVF1002X89	73138	89PR10K
R18	MF 68.1K	RESMF6812XXX	16299	SMA-4
R19	PF 10K	RESPF1002050	18612	S102C
R20	MF 51.1K	RESMF5112XXX	16299	SMA-4
R21	MF 511K	RESMF5113XXX	16299	SMA-4
R22	MF 511K	RESMF5113XXX	16299	SMA-4
R23	Power 25K	RESHP2502X11	12697	C10F-25K
R23A	Power 25K	RESHP2502X11	12697	C10F-25K
R24	Power 1K	RESHP1001X50	91637	RH50-1K
R25	CC 330K	RESCC3303XXX	SAG6700	RC42GF334J
R26	CC 220K	RESCC2203XXX	01121	HB2245
R27	MF 1K	RESMF1001XXX	16299	SMA-4
R28	MF 10K	RESMF1002XXX	16299	SMA-4
R29	MF 51.1K	RESMF5112XXX	16299	SMA-4
R30	Variable 1K	RESVF1001X89	73138	89PR1K
R31	MF 511	RESMF511XXXX	16299	SMA-4
R32	Variable 20K	RESVF2002X89	73138	89PR20K
R33	MF 68.1K	RESMF6812XXX	16299	SMA-4
R34	MF 215	RESMF215XXXX	16299	SMA-4
R35	MF 5.11K	RESMF5111XXX	16299	SMA-4

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
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Integrated Circuits Linear

AR1	Regulator +5V	REG05VPOS03A	27014	LM323K
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Capacitors

C1	Cer. Disc	0.1uf	CAPCD1003050	04222	3429-050E-104M
C2	Cer. Disc	0.1uf	CAPCD1003050	04222	3429-050E-104M
C3	Cer. Disc	0.1uf	CAPCD1003050	04222	3429-050E-104M
C4	Cer. Disc	0.1uf	CAPCD1003050	04222	3429-050E-104M
C5	Not Used				
C6	Cer. Disc	0.1uf	CAPCD1003050	04222	3429-050E-104M
C7	Cer. Disc	0.1uf	CAPCD1003050	04222	3429-050E-104M
C8	Cer. Disc	0.1uf	CAPCD1003050	04222	3429-050E-104M
C9	Cer. Disc	0.1uf	CAPCD1003050	04222	3429-050E-104M
C10	Cer. Disc	0.1uf	CAPCD1003050	04222	3429-050E-104M
C11	Cer. Disc	0.1uf	CAPCD1003050	04222	3429-050E-104M
C12	Cer. Disc	0.1uf	CAPCD1003050	04222	3429-050E-104M
C13	Cer. Disc	0.1uf	CAPCD1003050	04222	3429-050E-104M
C14	Cer. Disc	0.1uf	CAPCD1003050	04222	3429-050E-104M
C15	Cer. Disc	0.1uf	CAPCD1003050	04222	3429-050E-104M
C16	Cer. Disc	0.1uf	CAPCD1003050	04222	3429-050E-104M
C17	Cer. Disc	0.1uf	CAPCD1003050	04222	3429-050E-104M
C18	Cer. Disc	0.1uf	CAPCD1003050	04222	3429-050E-104M
C19	Cer. Disc	0.1uf	CAPCD1003050	04222	3429-050E-104M
C20	Cer. Disc	0.1uf	CAPCD1003050	04222	3429-050E-104M
C21	Cer. Disc	0.1uf	CAPCD1003050	04222	3429-050E-104M
C22	Cer. Disc	0.1uf	CAPCD1003050	04222	3429-050E-104M
C23	Cer. Disc	0.1uf	CAPCD1003050	04222	3429-050E-104M
C24	Cer. Disc	0.1uf	CAPCD1003050	04222	3429-050E-104M
C25	Cer. Disc	0.1uf	CAPCD1003050	04222	3429-050E-104M
C26	Cer. Disc	0.1uf	CAPCD1003050	04222	3429-050E-104M
C27	Cer. Disc	0.1uf	CAPCD1003050	04222	3429-050E-104M
C28	Not Used				
C29	Not Used				
C30	Not Used				
C31	Dipped Mica	22pf	CAPDM22XX500	14655	CD15ED220J03
C32	Dipped Mica	22pf	CAPDM22XX500	14655	CD15ED220J03
C33	Al. Elec.	10uf	CAPAL1005050	MAR611	CEO2WH100C
C34	Cer. Disc	0.01uf	CAPCD1002100	56289	TG-S10
C35	Al. Elect.	10uf	CAPAL1005050	MAR611	CEO2WH100C
C36	aal. Elect.	20uf	CAPAL2005050	56289	TE1305
C37	Cer. Disc	0.1uf	CAPCD1003050	04222	3429-050E-104M
C38	Cer. Disc	0.1uf	CAPCD1003050	04222	3429-050E-104M
C39	Cer. Disc	0.1uf	CAPCD1003050	04222	3429-050E-104M
C40	Cer. Disc	0.1uf	CAPCD1003050	04222	3429-050E-104M
C41	Cer. Disc	0.1uf	CAPCD1003050	04222	3429-050E-104M
C42	Cer. Disc	0.01uf	CAPCD1002100	56289	TG-S10

Diodes

CR1	Rectifier	DIOCR4002XXX	07263	1N4002
CR2	Rectifier	DIOCR4002XXX	07263	1N4002

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
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Integrated Circuits Digital

IC1	Timer	ICDTIMERX555	18324	NE555V
IC2	Nand Gate	ICDNANDXLS00	27014	74LS00
IC3	Nand Gate	ICDNANDXLS00	27014	74LS00
IC4	Hex Inverter	ICDINVXXLS04	02195	74LS04
IC5	Not Used			
IC6	Nand Gate	ICDNANDXLS00	27014	74LS00
IC7	Dual J-K Flip-Flop	ICDJKFFXLS73	02195	74LS73
IC8	Interface	ICDPIAMC6821	04713	MC6821P
IC9	Quad Comp. Output	ICDCMPOUT265	02195	74265
IC10	Buffer	ICDBUFFLS244	02195	74LS244
IC11	E PROM	ICDEPROM2732	HIT640	HM462732G
IC12	Microprocessor	ICDMPUMC6802	04713	MC6802P
IC13	Decoder	ICDDECXLS154	02195	74LS154
IC14	D Type Flip-Flop	ICDFFFXLS374	27014	74LS374
IC15	GPIO Interface	ICDGPIOA68488	04713	MC68488P
IC16	D Type Flip-Flop	ICDFFFXLS374	27014	74LS374
IC17	D Type Flip-Flop	ICDFFFXLS374	27014	74LS374
IC18	D Type Flip-Flop	ICDFFFXLS374	27014	74LS374
IC19	D Type Flip-Flop	ICDFFFXLS374	27014	74LS374
IC20	D Type Flip-Flop	ICDFFFXLS374	27014	74LS374
IC21	D Type Flip-Flop	ICDFFFXLS374	27014	74LS374
IC22	D Type Flip-Flop	ICDFFFXLS374	27014	74LS374
IC23	Buffer	ICDUUFFLS244	02195	74LS244
IC24	Bus Transceiver	ICDTRANS3448	04713	MC3448P
IC25	Bus Transceiver	ICDTRANS3448	04713	MC3448P
IC26	Bus Transceiver	ICDTRANS3448	04713	MC3448P
IC27	Bus Transceiver	ICDTRANS3448	04713	MC3448P
IC28	Not Used			
IC29	D Type Flip-Flop	ICDFFFXLS374	27014	74LS374

Resistors

R1	MF 5.11K	RESMF5111XXX	16299	SMA-4
R2	MF 5.11K	RESMF5111XXX	16299	SMA-4
R3	MF 5.11K	RESMF5111XXX	16299	SMA-4
R4	MF 5.11K	RESMF5111XXX	16299	SMA-4
R5	MF 14.7K	RESMF1472XXX	16299	SMA-4
R6	MF 5.11K	RESMF5111XXX	16299	SMA-4
R7	MF 5.11K	RESMF5111XXX	16299	SMA-4
R8	MF 10K	RESMF1002XXX	16299	SMA-4
R9	MF 5.11K	RESMF5111XXX	16299	SMA-4
R10	MF 5.11K	RESMF5111XXX	16299	SMA-4
R11	MF 51.1K	RESMF5112XXX	16299	SMA-4
R12	MF 5.11K	RESMF5111XXX	16299	SMA-4
R13	MF 51.1K	RESMF5112XXX	16299	SMA-4
R14	MF 51.1K	RESMF5112XXX	16299	SMA-4
R15	MF 51.1K	RESMF5112XXX	16299	SMA-4
R16	MF 5.11K	RESMF5111XXX	16299	SMA-4

Resistor Networks

RU1	6 Pin SIP 10K	RESS11002XX5	16299	LC6001-1002G
RU2	6 Pin SIP 10K	RESS11002XX5	16299	LC6001-1002G

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
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Precision Diodes

VR1		DIOTS6R86267	24444	1.5KE6.8
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Crystal

Y1	3.2MHz	XTAL3R2MHZXX	71450	MP-031
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Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
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Capacitors

C1	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C2	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10
C3	Cer. Disc 0.01uf	CAPCD1002100	56289	TG-S10

Integrated Circuits Digital

IC1	7 Segment to BCD	ICDSEGBCD915	27014	74C915N
IC2	7 Segment to BCD	ICDSEGBCD915	27014	74C915N
IC3	7 Segment to BCD	ICDSEGBCD915	27014	74C915N

Resistors

R1	Part of RU1			
R2	Part of RU1			
R3	Part of RU1			
R4	Part of RU1			
R5	Part of RU1			
R6	Part of RU2			
R7	Part of RU1			
R8	Part of RU1			
R9	Part of RU1			
R10	Part of RU2			
R11	Part of RU2			
R12	Part of RU2			
R13	Part of RU2			
R14	Part of RU2			
R15	Part of RU2			
R16	Part of RU2			
R17	MF 51.1K	RESMF5112XXX	16299	SMA-4
R18	Part of RU4			
R19	Part of RU4			
R20	Part of RU4			
R21	Part of RU4			
R22	Part of RU4			
R23	Part of RU5			
R24	Part of RU5			
R25	Part of RU5			
R26	Part of RU5			
R27	Part of RU5			
R28	Part of RU5			
R29	Part of RU5			
R30	Part of RU3			
R31	Part of RU3			
R32	Part of RU3			
R33	Part of RU3			
R34	Part of RU3			
R35	Part of RU3			
R36	Part of RU3			

Resistor Networks

RU1	16 Pin DIP 47K	RESD14702XX8	16299	D16002-4702G
RU2	16 Pin DIP 47K	RESD14702XX8	16299	D16002-4702G

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
RU3	8 Pin SIP 47K	RES14702XX7	16299	LC8001-4702G
RU4	6 Pin SIP 47K	RES14702XX5	16299	LC6001-4702G
RU5	8 Pin SIP 47K	RES14702XX7	16299	LC8001-4702G

Transistors

Q1	Signal PNP	TRASPS55XXX	09212	MPSA55
Q2	Signal PNP	TRASPS55XXX	09212	MPSA55
Q3	Signal PNP	TRASPS55XXX	09212	MPSA55
Q5	Signal PNP	TRASPS55XXX	09212	MPSA55
Q6	Signal PNP	TRASPS55XXX	09212	MPSA55
Q7	Signal PNP	TRASPS55XXX	09212	MPSA55
Q8	Signal PNP	TRASPS55XXX	09212	MPSA55
Q9	Signal PNP	TRASPS55XXX	09212	MPSA55
Q10	Signal PNP	TRASPS55XXX	09212	MPSA55
Q11	Signal PNP	TRASPS55XXX	09212	MPSA55
Q12	Signal PNP	TRASPS55XXX	09212	MPSA55
Q13	Signal PNP	TRASPS55XXX	09212	MPSA55
Q14	Signal PNP	TRASPS55XXX	09212	MPSA55
Q15	Signal PNP	TRASPS55XXX	09212	MPSA55
Q16	Signal PNP	TRASPS55XXX	09212	MPSA55

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
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S2B

Transistors

Q1	Signal PNP	TRASPSA44XXX	09212	MPSA55
Q2	Signal NPN	TRASNSA05XXX	09212	MPSA05
Q3	Switch PNP	TRASP2946XXX	07933	2N2946A

Diodes

CR1	Signal	DIOCRN914XXX	07263	1N914
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Resistors

R1	MF 10K	RESMF1002XXX	16299	SMA-4
R2	MF 2.15K	RESMF2151XXX	16299	SMA-4
R3	MF 1 Meg	RESMF1004XXX	16299	SMA-4
R4	MF 511	RESMF511XXXX	16299	SMA-4
R5	MF 511	RESMF511XXXX	16299	SMA-4

(Assembly 07-117-000 switch U-11 only)

R1	MF 2.15K	RESMF2151XXX	16299	SMA-4
R2	MF 681	RESMF681XXXX	16299	SMA-4

(Assembly 07-119-000 switch U9 only)

C1	Dipped Mica 33pf	CAPCD33XX500	14566	CD15ED330J03
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S2B-ATT

Transistors

Same as S2B

Diodes

Same as S2B

Resistors

Same As S2B

(Assembly 07-115-000 switch U34, U35 only)

R3	MF 51.1K	RESMF5112XXX	16299	SMA-4
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(Assembly 07-115-000 switch U36 only)

R3	MF 68.1K	RESMF6812XXX	16299	SMA-4
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S2B-AC

Transistors

Same as S2B

Diodes

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
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Same as S2B

Resistors

R1	MF 2.15K	RESMF2151XXX	16299	SMA-4
R2	MF 681	RESMF681XXXX	16299	SMA-4
R3	MF 1 Meg	RESMF1004XXX	16299	SMA-4
R4	MF 511	RESMF511XXXX	16299	SMA-4
R5	MF 511	RESMF511XXXX	16299	SMA-4

S1BAC2 and S1B-ATT

Transistors

Q1	Signal PNP	TRASPSA55XXX	09212	MPSA55
Q2	Signal NPN	TRASNSA05XXX	09212	MPSA05
Q3	Switch PNP	TRASP2946XXX	07933	2N2946A
Q4	FET	TRAFNF231XXX	04713	2N4860

Diodes

CR1	Signal	DIOCRN914XXX	07263	1N914
CR2	Signal	DIOCRN914XXX	07263	1N914
CR3	Signal	DIOCRN914XXX	07263	1N914

Resistors

R1	MF 10K	RESMF1002XXX	16299	SMA-4
R2	MF 511	RESMF511XXXX	16299	SMA-4
R3	MF 1 Meg	RESMF1004XXX	16299	SMA-4
R4	MF 100K	RESMF1003XXX	16299	SMA-4
R5	MF 14.7K	RESMF1472XXX	16299	SMA-4
R6	MF 2.15K	RESMF2151XXX	16299	SMA-4
R7	MF 511	RESMF511XXXX	16299	SMA-4

S1BAC1

Transistors

Same as S1BAC2

Diodes

Same as S1BAC2

Resistors

R1	MF 1.47K	RESMF1471XXX	16299	SMA-4
R2	MF 511	RESMF511XXXX	16299	SMA-4
R3	MF 1 Meg	RESMF1004XXX	16299	SMA-4
R4	MF 21.5K	RESMF2152XXX	16299	SMA-4
R5	MF 3.48K	RESMF3481XXX	16299	SMA-4
R6	MF 681	RESMF681XXXX	16299	SMA-4
R7	MF 511	RESMF511XXXX	16299	SMA-4

Symbol	Description	Rotek P/N	Mfg. Code	Mfg. P/N
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S4

Transistors

Q1	Signal PNP	TRASPSA55XXX	09212	MPSA55
Q2	Signal NPN	TRASNSA05XXX	09212	MPSA05
Q3	Switch FET	TRAFN4860XXX	04713	2N4860

Diodes

CR1	Signal	DIOCRN914XXX	07263	1N914
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Resistors

R1	MF 14.7K	RESMF1472XXX	16299	SMA-4
R2	MF 3.48K	RESMF3481XXX	16299	SMA-4
R3	MF 100K	RESMF1003XXX	16299	SMA-4
R4	MF 3.48K	RESMF3481XXX	16299	SMA-4
R5	MF 511	RESMF511XXXX	16299	SMA-4

S6

Transistors

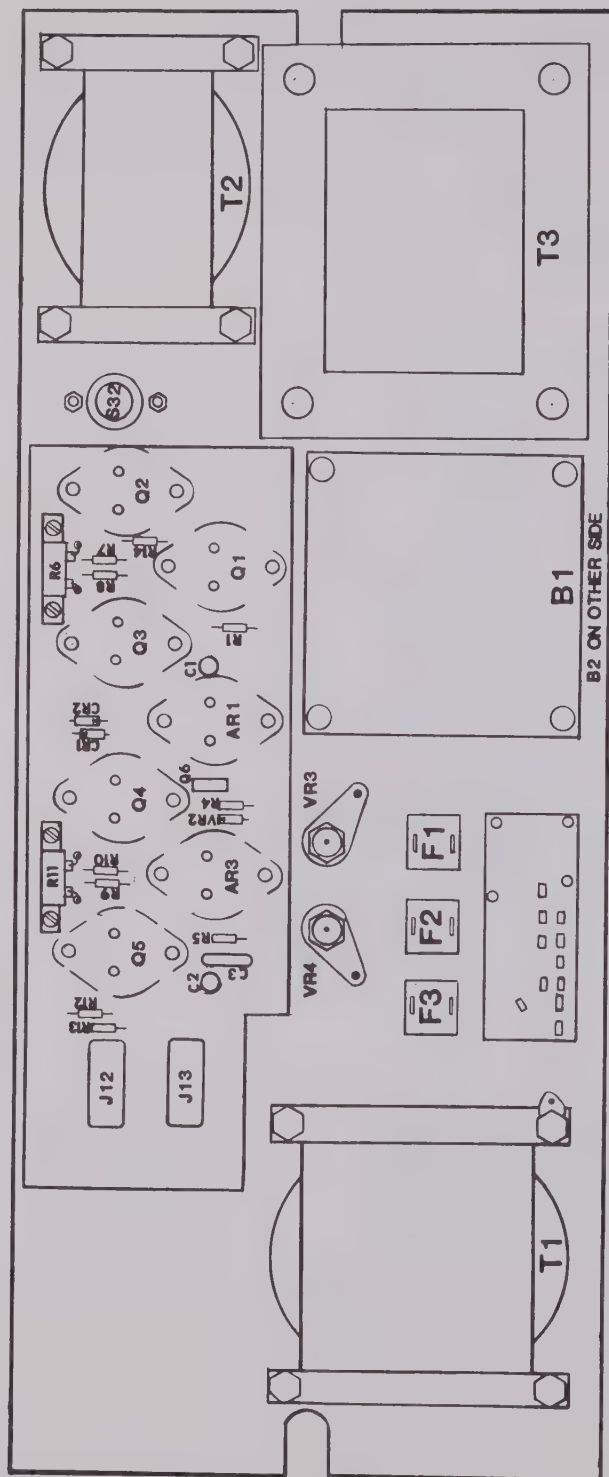
Q1	Signal PNP	TRASPSA55XXX	09212	MPSA55
Q2	Signal NPN	TRASNSA05XXX	09212	MPSA05
Q3	Switch PNP	TRASP2946XXX	07933	2N2946A

Diodes

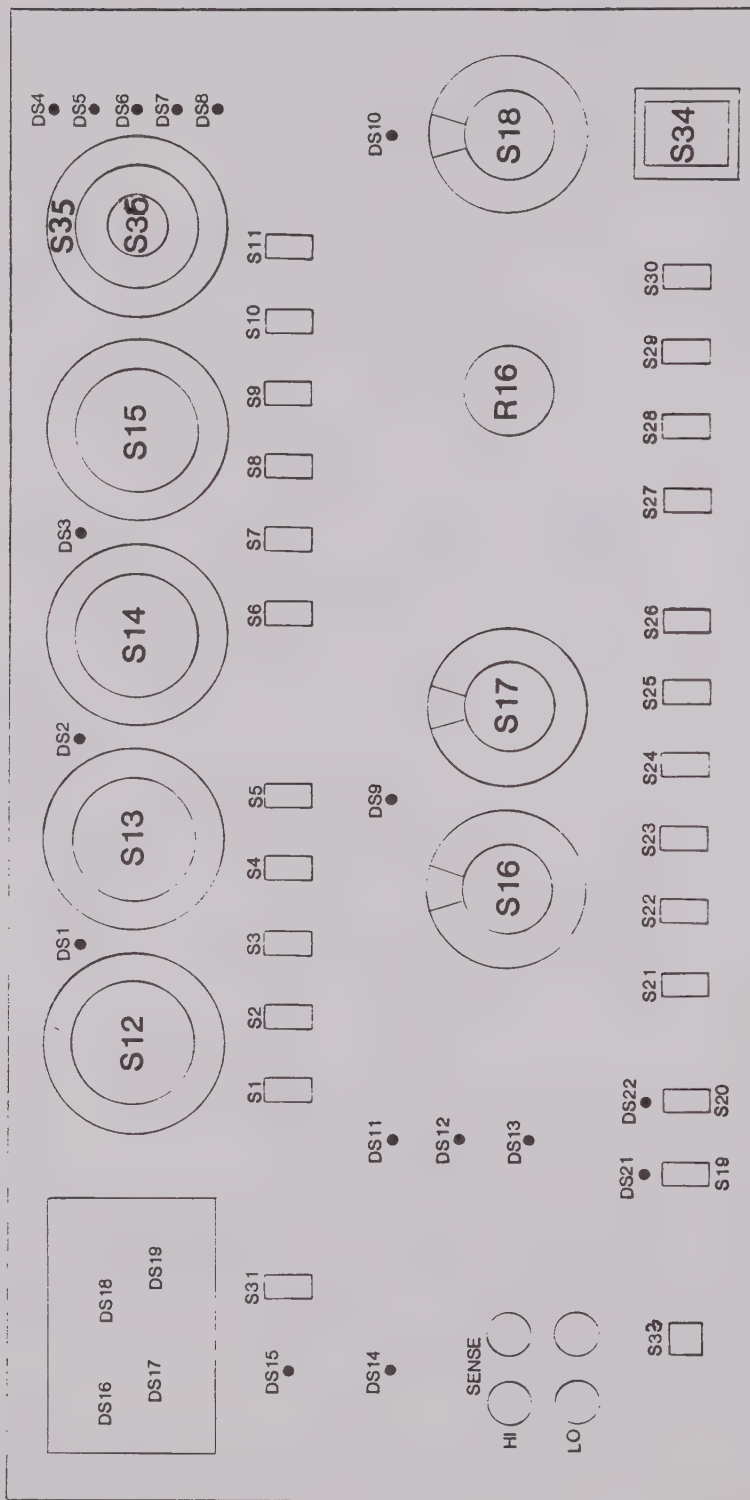
CR1	Signal	DIOCRN914XXX	07263	1N914
CR2	Signal	DIOCRN914XXX	07263	1N914
CR3	Signal	DIOCRN914XXX	07263	1N914
CR4	Signal	DIOCRN914XXX	07263	1N914
CR5	Signal	DIOCRN914XXX	07263	1N914

Resistors

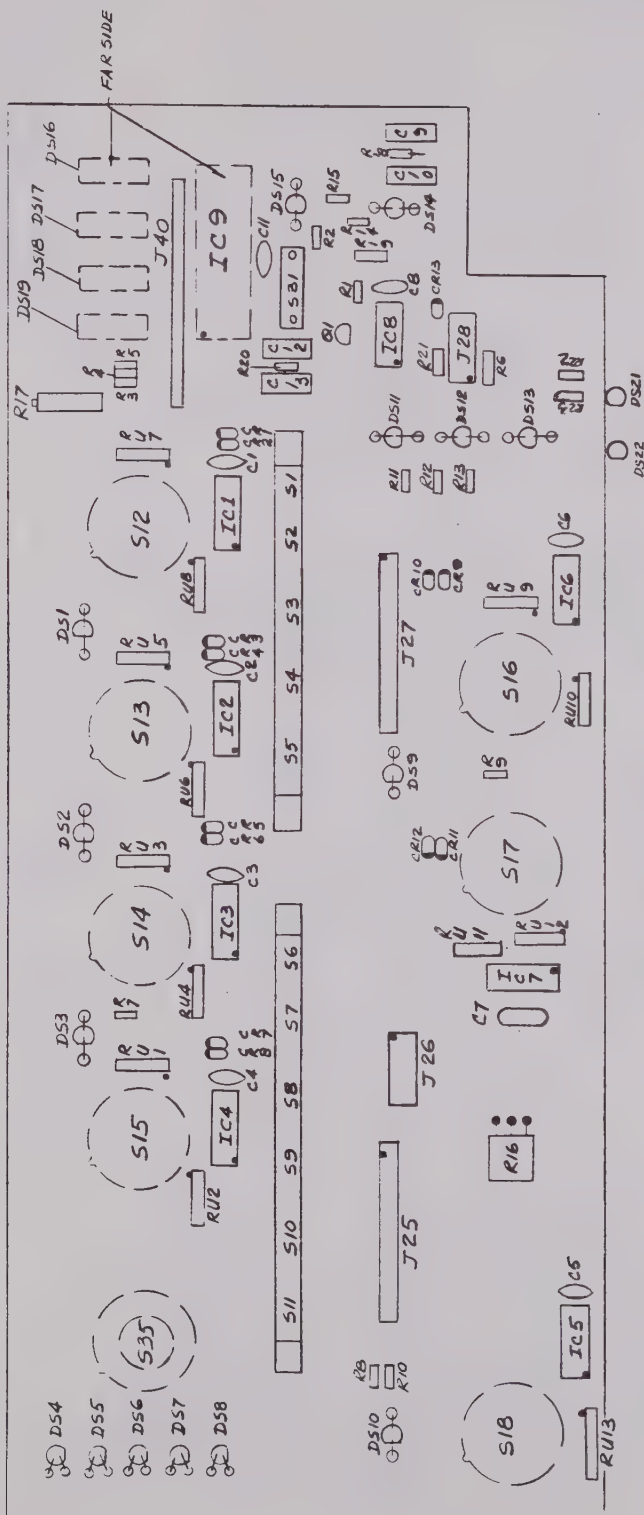
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R2	MF 21.5K	RESMF2152XXX	16299	SMA-4
R3	MF 6.81K	RESMF6811XXX	16299	SMA-4
R4	MF 2.15K	RESMF2151XXX	16299	SMA-4
R5	MF 6.81K	RESMF6811XXX	16299	SMA-4
R6	MF 511	RESMF511XXXX	16299	SMA-4
R7	MF 511K	RESMF5113XXX	16299	SMA-4



SCALE		APPROVED BY	DESIGNED BY
DATE		2-8-84	M.W.
ROTEK INSTRUMENT CORP.			
REAR PANEL ASSY.		DRAWING NUMBER	
		07-105-000	



SCALE		APPROVED BY		DRAWN BY	
DATE		2-10-84		M.W.	
ROTEK INSTRUMENT CORP.					
LOCATION-FRONT PANEL				DRAWING NUMBER	
				07-104-000	



SC-11
DATE 4-10-84
APPROVED BY
DRAWN BY

ROTEK INSTRUMENT CORP.

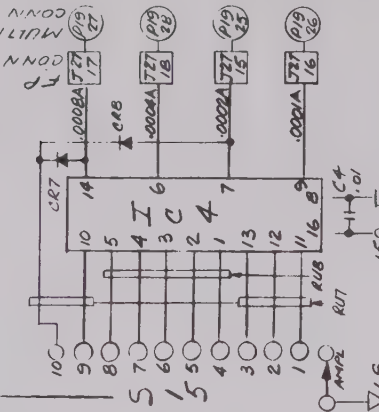
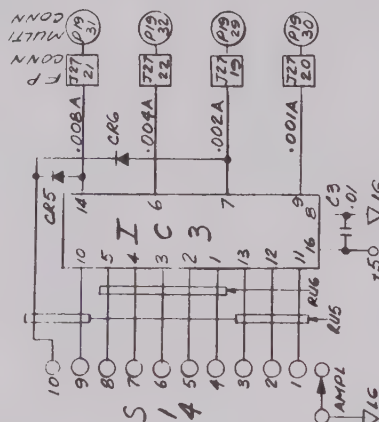
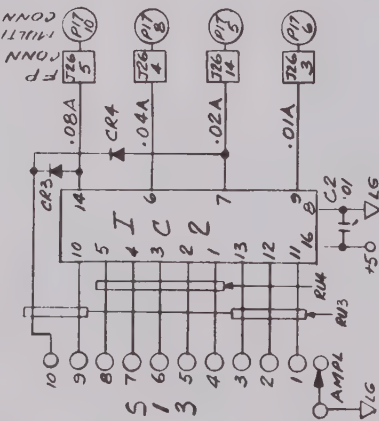
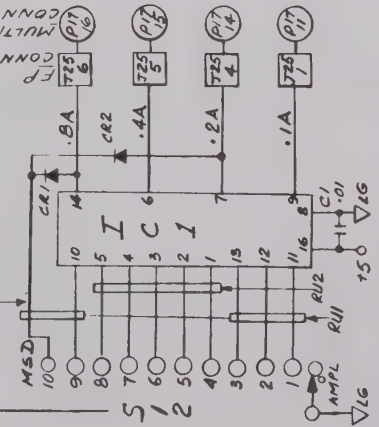
LOCATION F-PANEL R.C.B. 07-107-000



07000-001 F

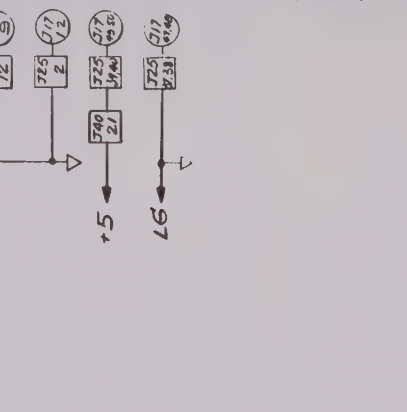
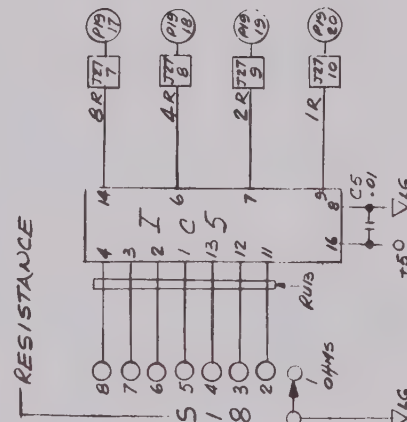
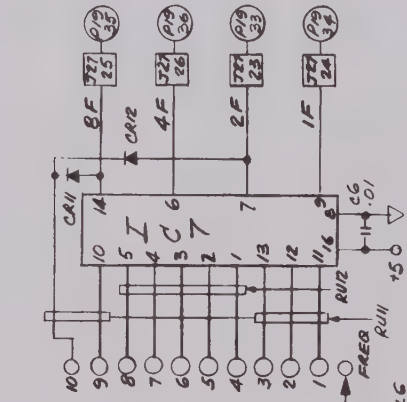
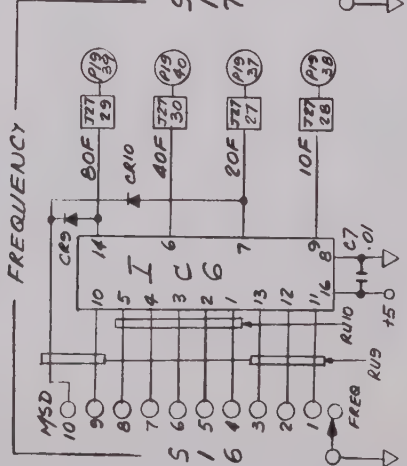
AMPLITUDE

ALL LINES HAVE 47KS.
RESISTORS TO 15
(RESISTOR PACK RU1)

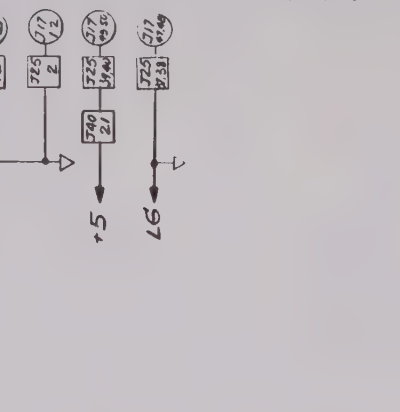
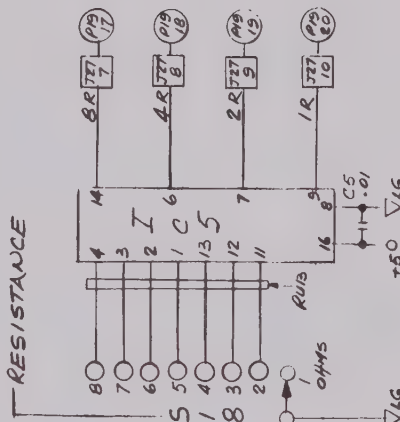


SEE 07-117-001A SHEET 2
FOR 5TH & 6TH DIGIT

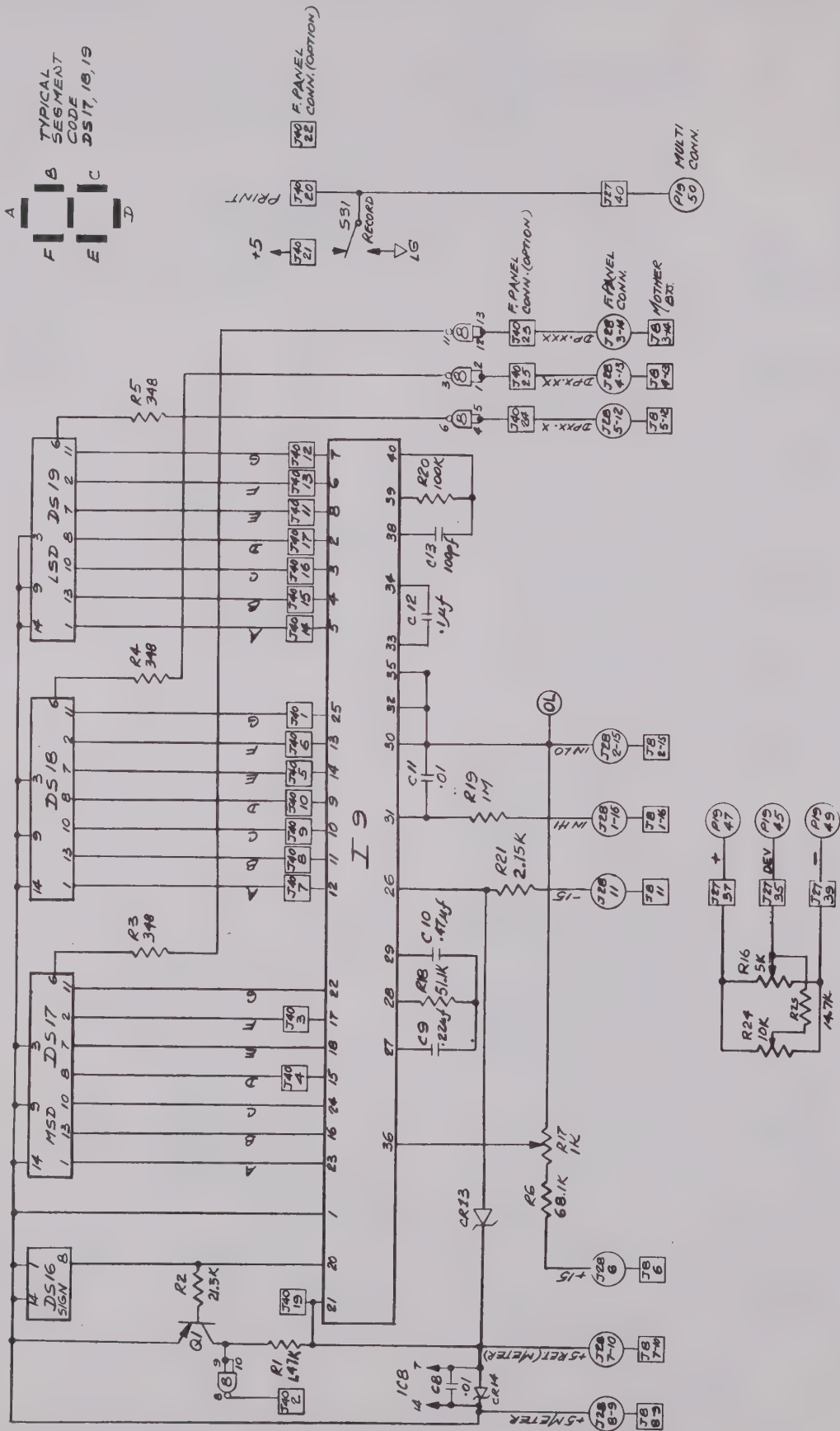
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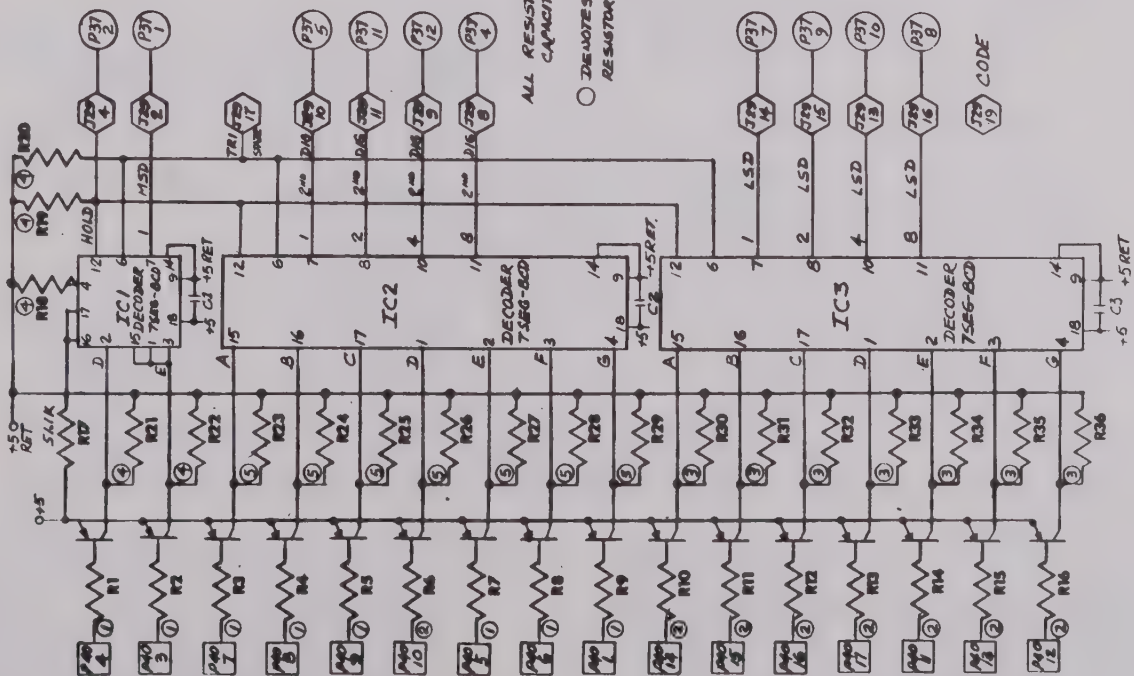


RESISTANCE



SCALE	DATE	APPROVED BY	DRAWN BY
4-4-54	4-4-54		
ROTEK INSTRUMENT CORP.			
SCHEMATIC-F. PANEL			
07-101-001			



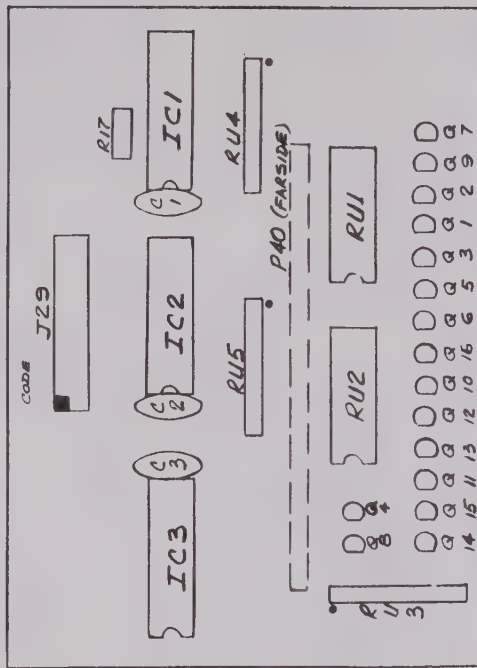


ALL RESISTORS 47K EXCEPT R17

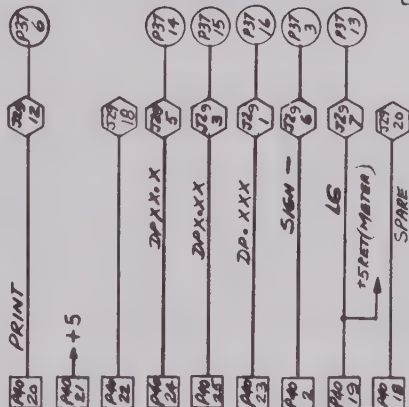
CAPACITORS .001

○ DENOTES RU PACKAGE

RESISTOR 1/8 PART OF

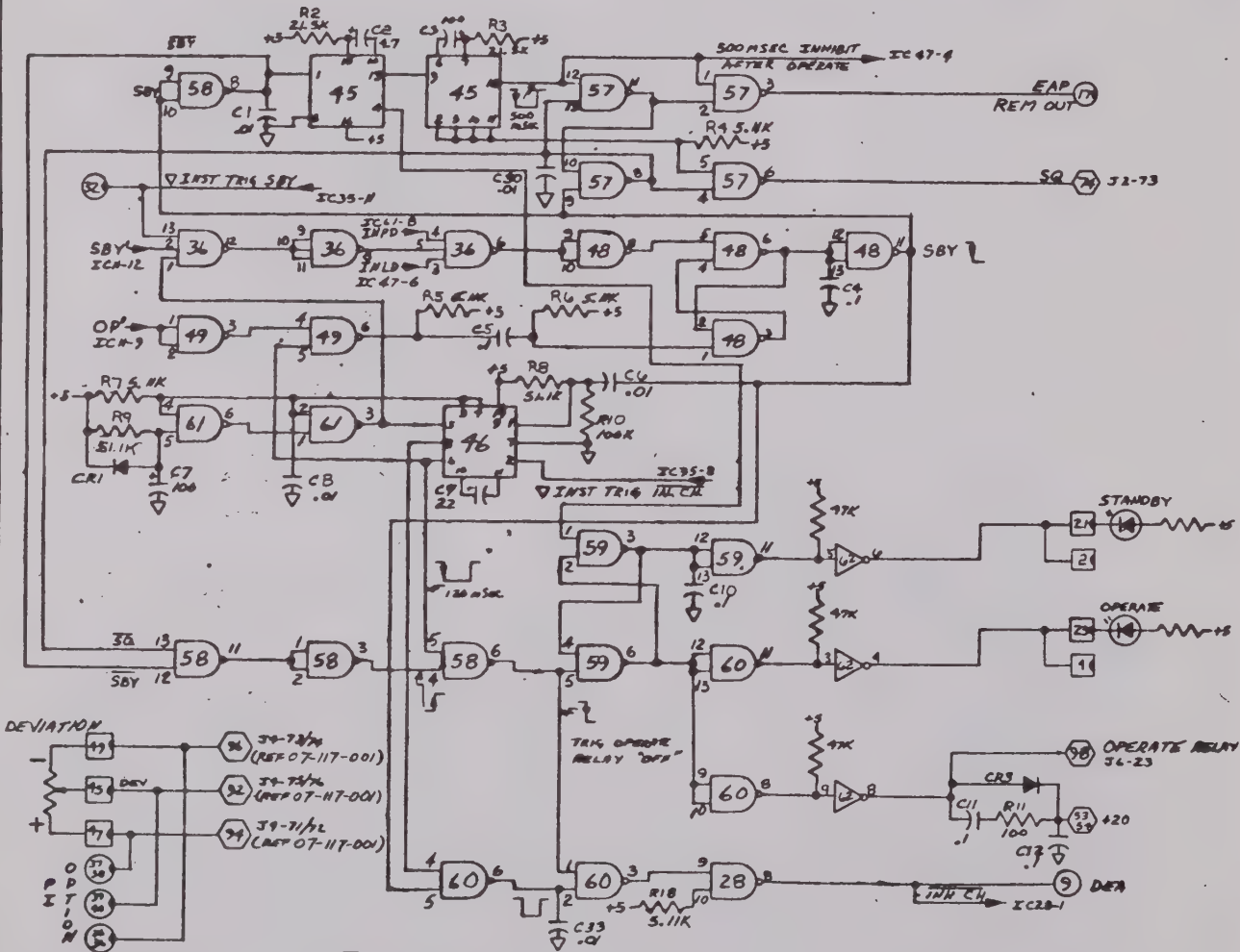
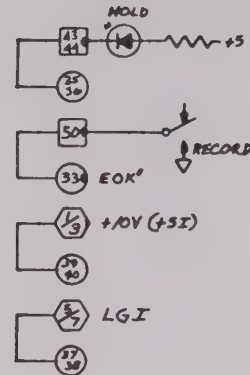
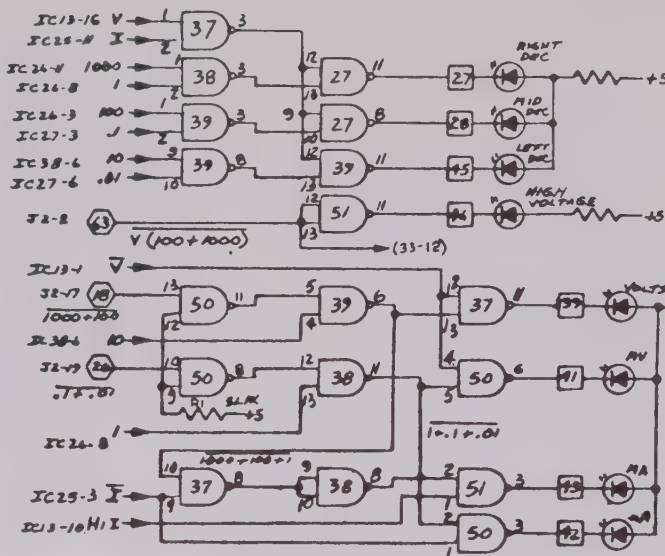


LOCATION-ASSY DECODER
TSEG-BCD

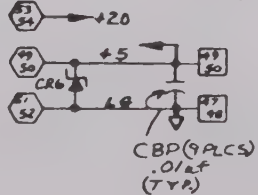


SCALE	APPROVED BY	DATE	DESIGNED BY
ROTEK INSTRUMENT CORP.			
SCHEMATIC-DECODER			
C7-200-001			

710 BCD



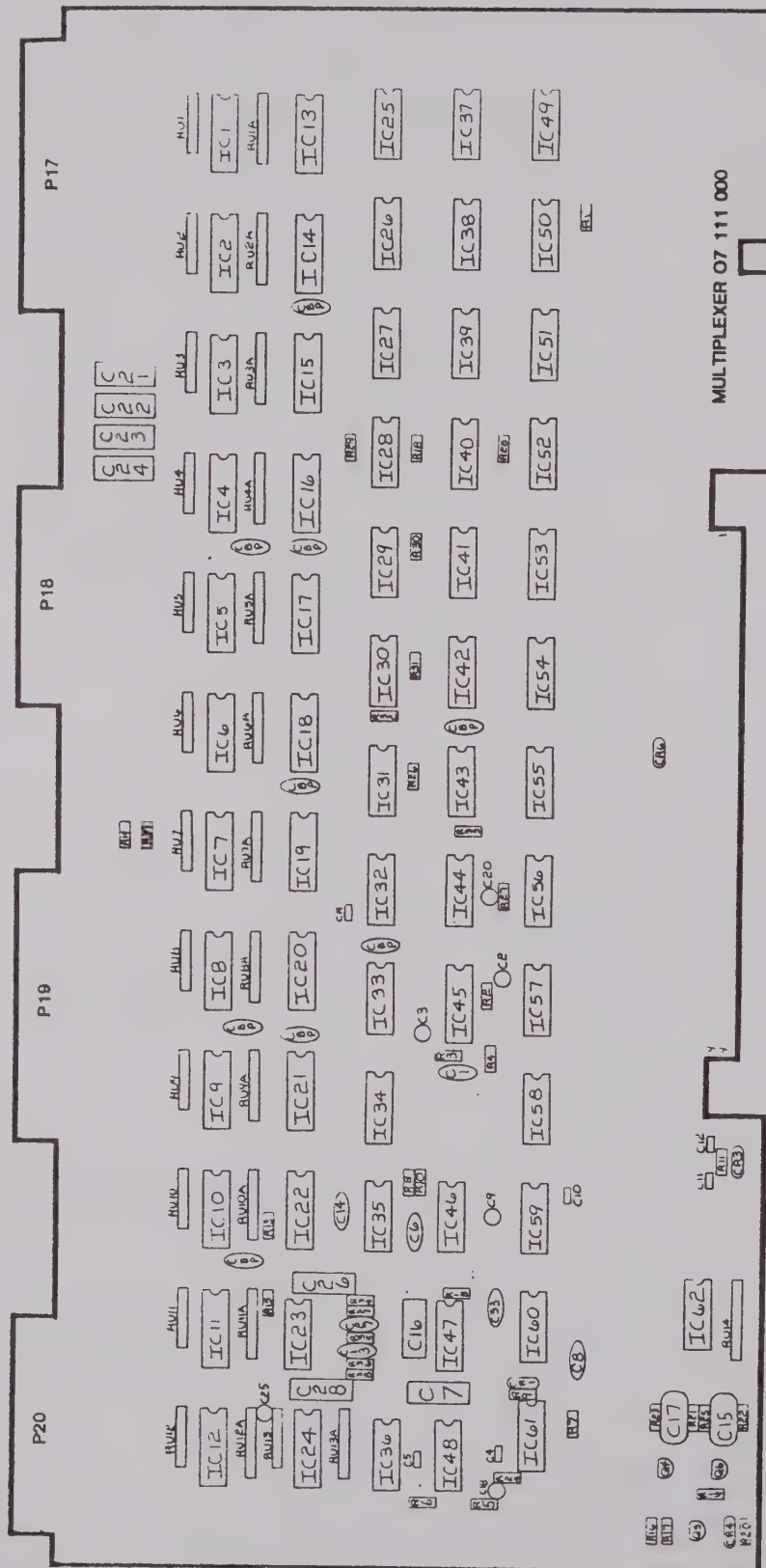
- P1 BACKBOARD
- P17 TO P25 FRONT PANEL
- P18 TO P1/IEEE P38
- P19 TO P7 BACKBOARD
- P20 TO P1/IEEE P39



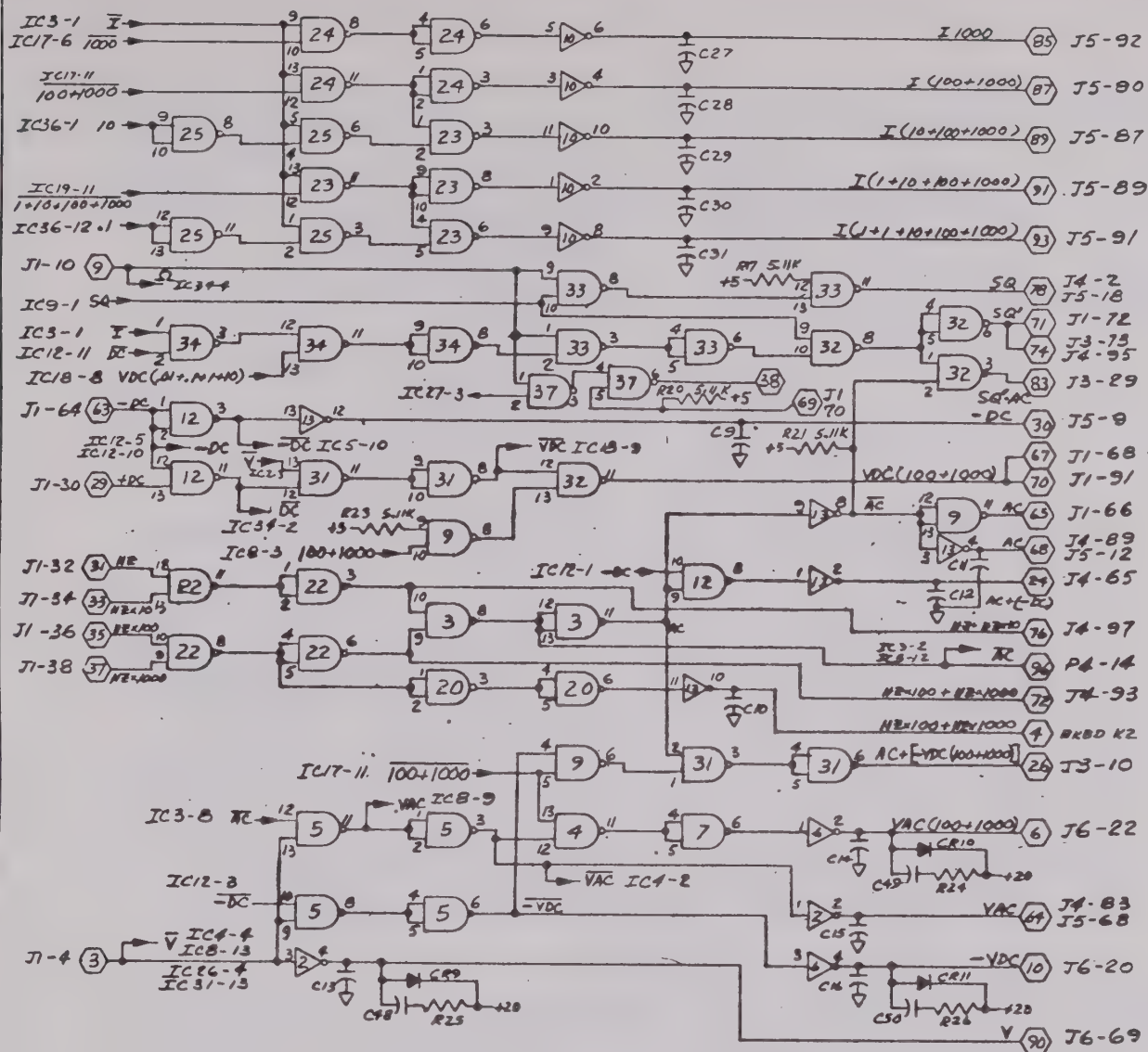
SCALE			APPROVED BY			DATE		
ROTEK INSTRUMENT CORP.			MULTIPLEXER			DRAWING NUMBER V4		
07-111-001 B								





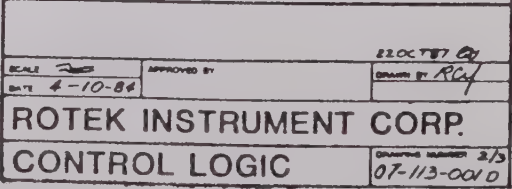


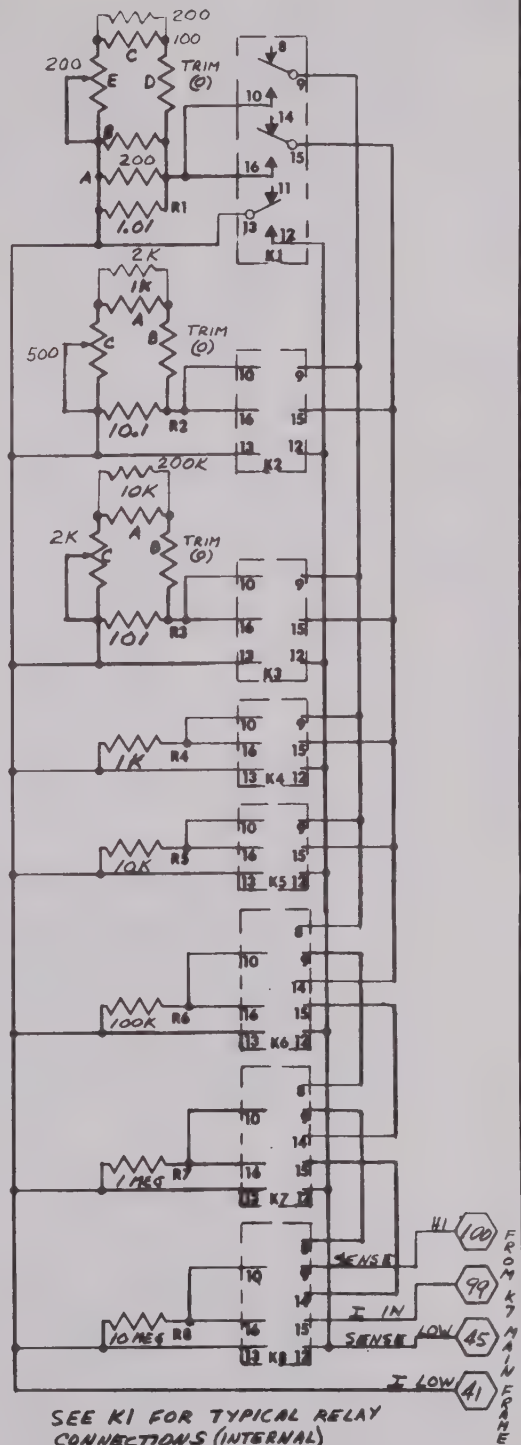
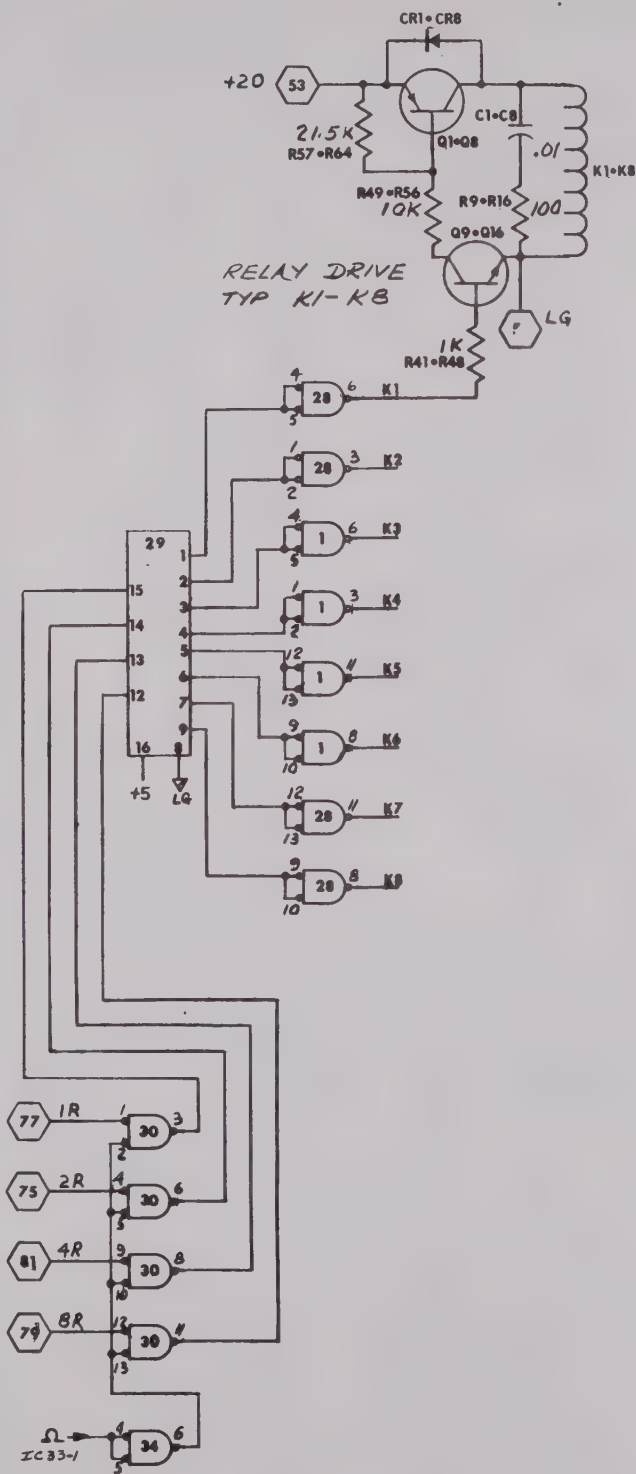
SCALE	APPROVED BY	DATE	DATE BY
		10.15.85	
ROTEK INSTRUMENT CORP.			DRAWING NUMBER
MULTIPLEXER			07-111-000



UNLESS OTHERWISE NOTED
ALL CAPACITORS ARE .01μf
ALL RESISTORS ARE 100Ω

SCALE $\approx$		APPROVED BY	PROJECT 87
DATE		DESIGNED BY RCL	
ROTEK INSTRUMENT CORP.			
CONTROL LOGIC			SHOWN PLANS 1/3 07-113-001C





SEE K1 FOR TYPICAL RELAY
CONNECTIONS (INTERNAL)

SCALE	APPROVED BY	DRAWN BY
DATE 4-10-84		RCY
ROTEK INSTRUMENT CORP.		
CONTROL LOGIC		
DRAWING NUMBER 3/3		07-113-001 A

R2B

R1D

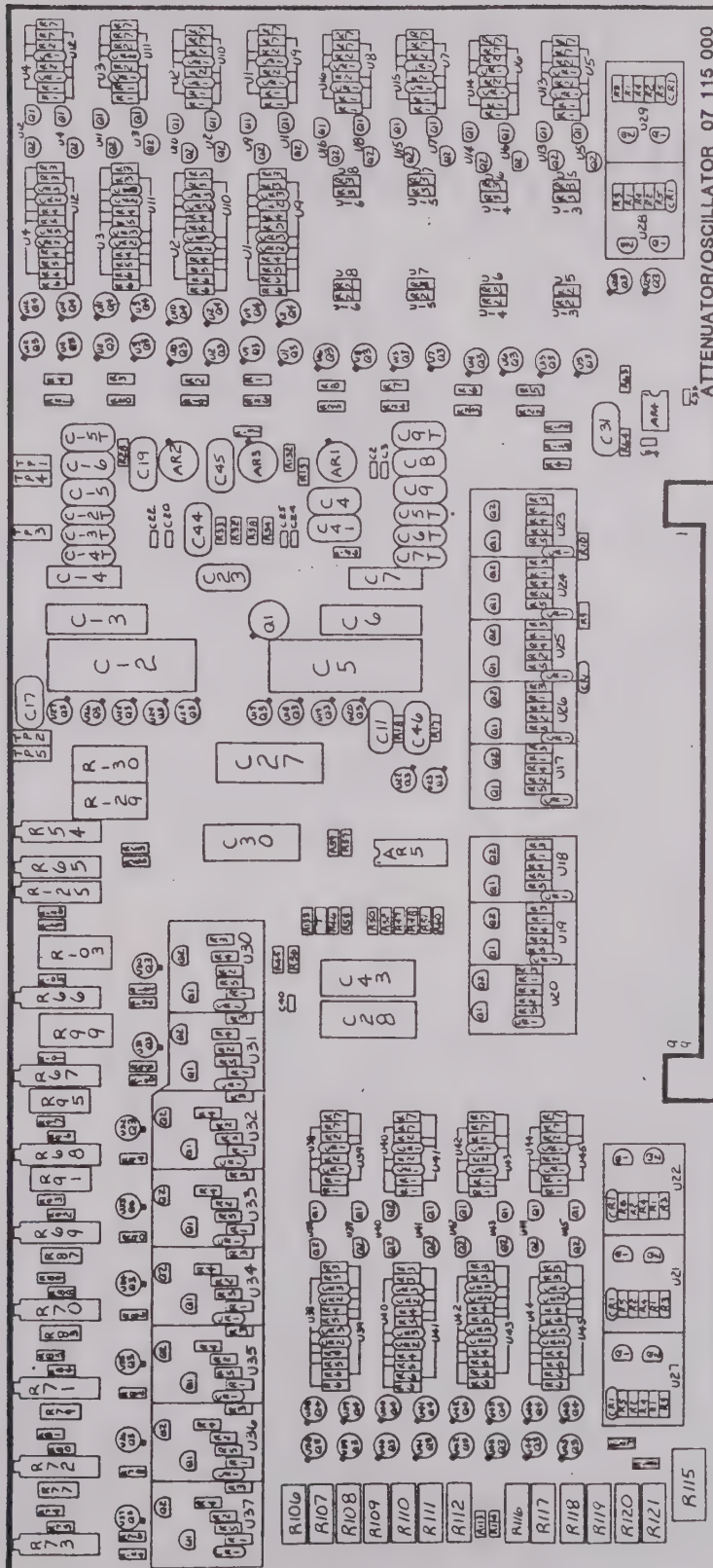
R1A

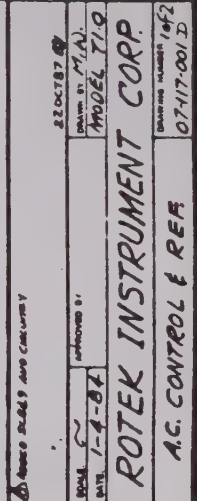
R1B

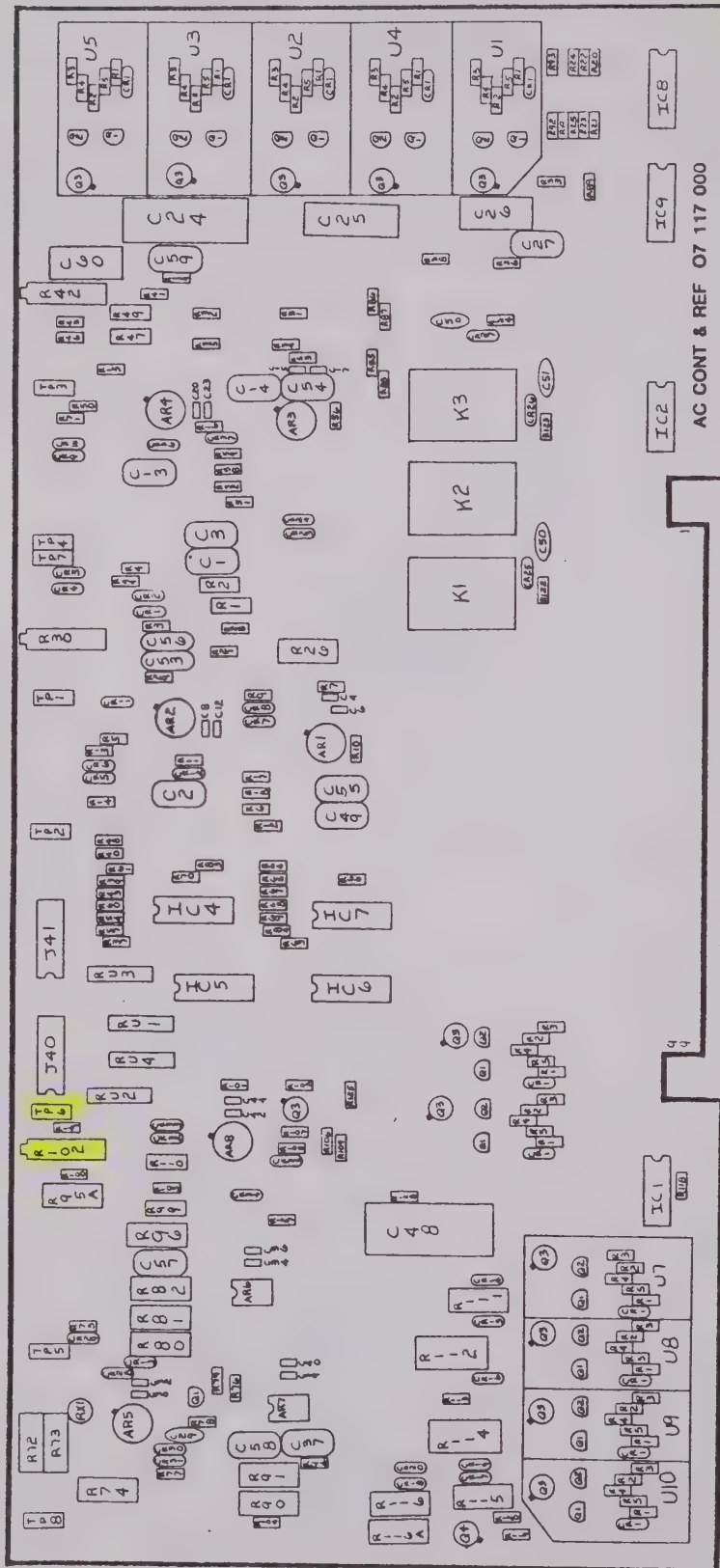
R1
R2
R3
ECCREAR OF PC
BOARD

CONTROL LOGIC 07 113 000

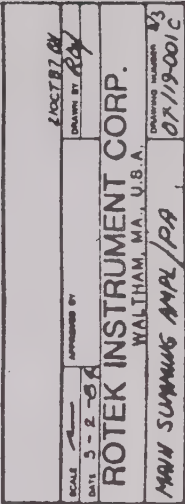
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		10/15/85	
ROTEK INSTRUMENT CORP.			DRAWING NUMBER
CONTROL LOGIC			07-113-000

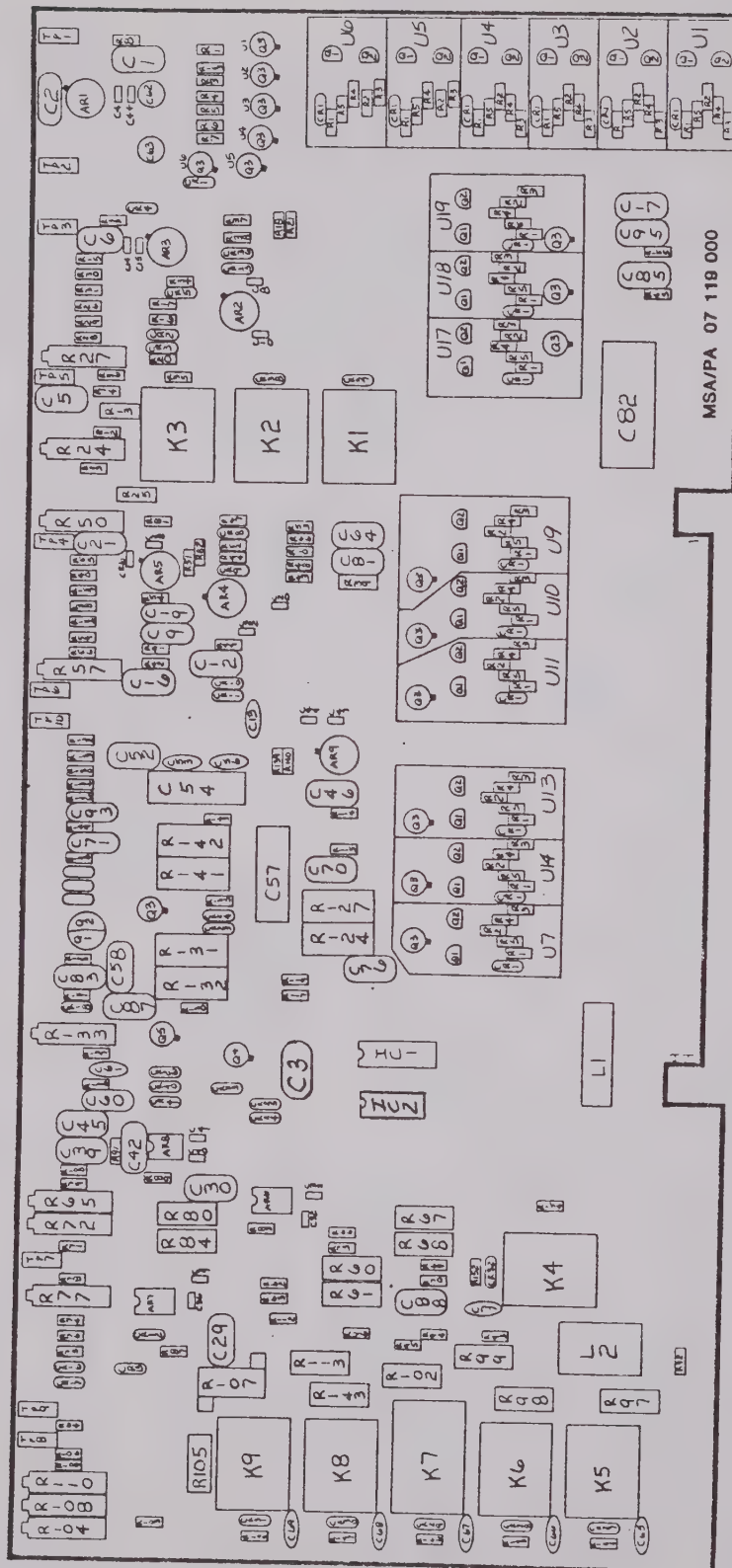



$$K_3 = AC + (-DC)$$



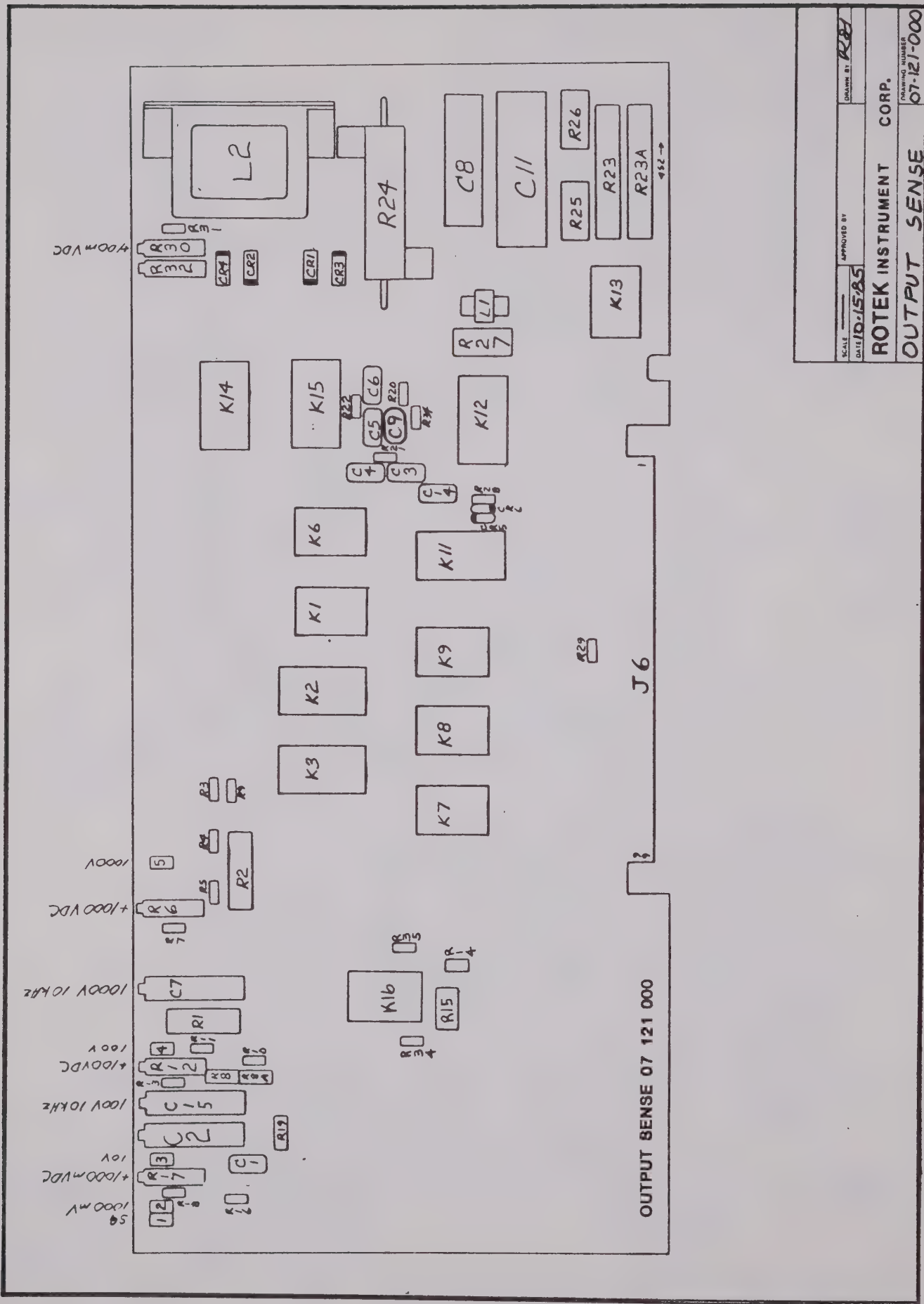
SCALE	DATE	APPROVED BY	DRAWN BY
	10-15-85		R2
ROTEK INSTRUMENT CORP.			
AC CONT REF			
DRAWING NUMBER 07-117-000			





MSA/PA 07 119 000

SCALE	DATE	APPROVED BY	DRAWN BY
	10.15.85		P.4
ROTEK INSTRUMENT CORP.			DRAWING NUMBER
MSA/PA			07-119-000



SECTION 7

IEEE STD. 488-1975 INTERFACE

7.1 Description

The IEEE 488 Interface consists of circuits, along with a Microprocessor, performing in accordance with the Standard to provide two way ASCII communication between a controller and the Rotek Model 710. With this Interface the Rotek Model 710 functions as a Listener to receive data and status instructions. As a Talker, the Model 710 sends data and status information. In the Listener mode the following data can be received and acted upon.

Functions: Volts, Amps, High Amp, Ohms.

Range: 10, 100, 1000mV/uA, 10, 100, 1000V/mA.

Mode: +DC, -DC, Hz x 1, Hz x 10, Hz x 100, Hz x 1000.

Deviation range: 0.1, 1.0, 10%, OFF

Amplitude Setting: Most significant Digit (MSD), 2nd Digit, 3rd Digit, 4th Digit, 5th Digit, 6th Digit (Ohms value MSD Only).

Frequency Setting: MSD, 2nd Digit.

The Status instructions that can be received are:

Operate
Standby

The Model 710 transmits the following status information:

Deactivate state (Standby)
Activate state (Operate)
Error OK: (Record switch pressed)
710 uP is busy
710 is in the REMOTE state
710 requires service

The following data information is transmitted by the Model 710

Deviation: Polarity, MSD, 2nd Digit, 3rd Digit, Exponential Digit.

The Model 710 address is set on the five positions of SW1 of 06-137-000 Interface Module. SW1 is accessible on the top of the Interface module immediately under the top cover. The address is represented as a five digit binary number with the 1st position being the least significant bit and the 5th position being the most significant bit. The decimal equivalent of the binary number is often used in the address syntax. The Rotek 710 is usually set to the decimal

equivalent of 11 at the factory.

NOTE.

The binary address code is read by the uP only during the power up interval. If the address code is changed for any reason a cold power up is required for the uP to read the new address code.

A Rotek Model 710 with the IEEE Interface can be programmed by a remote controller to any function, amplitude setting, frequency and deviation range. It can also be placed in the Standby or Operate state. New amplitude setting, frequency setting and deviation range can be transmitted to the 710 in either the Operate or Standby state. Range and mode information can only be transmitted in the Standby state. The Model 710 asserts the service request status bit whenever one or more of the status functions is asserted; the controller can then conduct a serial poll and will receive the complete status byte from the Model 710. The Model 710 can also transmit the error message (the reading of the deviation meter).

7.2 Specifications IEEE Interface

The Model 710 performs in accordance with the following subsets of the Interface Standard.

Source Handshake	SH1
Acceptor Handshake	AH1
Listener	L4
Talker	T6
Service Request	SR1

7.2.1 Listener Function

Data Entry

1. Data is entered by a two byte instruction.
 - a. Alpha: F, R, M, D, S, T, U, V, W, Y, H, Z.
 - b. Numerical values (See table 7-1).
2. Typical data entry:
 - a. "FOR3MOD2S:T0U0V0W0Y0H0Z0".
Volts +dc, 10V, Dev. 1%
3. Alpha bytes must always precede numerics.
4. Data may be entered in any order; values not entered always retain the last assigned value.

Description	ASCII Character	Description	ASCII Character
Function	F	Dev. Range	D
Volts	0	OFF	0
Amps	1	0.1%	1
Hi Amps	3	1.0%	2
Ohms	4	10%	3
Range	R	Amplitude MSD, Ohms	S
10mV/uA	0	exponent	0-9, :=10
100mV/uA	1	Amplitude 2nd digit	T
1000mV/uA	2	value	0-9, :=10
10V/mA	3	Amplitude 3rd digit	U
100V/mA	4	Value	0-9, :=10
1000V/mA	5	Amplitude 4th digit	V
Mode	M	value	0-9, :=10
+DC	0	Amplitude 5th digit	W
		value	0-9, :=10
		Amplitude 6th digit	Y
		value	0-9, :=10
		Frequency MSD	H
-DC	1	value	0:9, :=10
Hz	2	Frequency LSD	Z
Hz x 10	3	value	0-9, :=10
Hz x 100	4	Standby	O
Hz x 1000	5	Operate	E

LISTENER CODES

Table 7-1

Status Bit number	Meaning when asserted
0 (lowest order)	Excitation Applied (EAP)
1	Error OK
2	Standby (DEA)
3	Always asserted
4	Not used
5	uP Busy
6	RQS
7 (highest order)	Remote state

STATUS BYTE

Table 7-2

Byte Sequence	Item Description
	Error Message
1	Polarity
2	MSD
3	2nd digit
4	3rd digit
5	Exponent Symbol
6	Exponent polarity
7	Exponent
8	Carriage Return
9	Line feed with EOI

TRANSMISSION OF ERROR MESSAGE

Table 7-3

5. It is always a smart practice to transmit the complete word every time. This can be easily done by assembling the word into a literal variable (string) and then outputting the variable.

7.2.2 Serial Poll Code

1. See Table 7-2
2. Excitation applied is a timed signal occurring after the output relays are activated and the squelch has been removed.
3. Standby is also a timed signal occurring after the squelch has been activated and output relay deactivated.
4. Error OK occurs whenever the Record Button is momentarily depressed.
5. RQS is asserted when any of the above bits have changed.

7.2.3 Transmitted Message (See Table 7-3 for formats.)

7.3 Typical Applications

This section describes the application of the Rotek Model 710 with the IEEE Interface and a controller to calibrate a multimeter. It does not provide a complete test routine for this purpose but rather shows typical instructions in a routine, assuming the controller to be a Hewlett Packard Model 9825 desk top calculator. The designation of the particular type of calculator is arbitrary as most of the 488/GPIB compatible devices can be used. Each calculator has its own unique syntax and therefore each program will look different.

Each task the uP is requested to perform takes a finite period of time during which the processor is unavailable for other tasks. The busy bit of the status byte is used for the purpose of determining whether the uP is standing "at the ready" and can be instructed to immediately perform further tasks.

7.3.1 Initializing

The state of the storage elements of the Calibrator may be unknown at the start of a given test routine, so it is best to establish a known set of conditions. This is accomplished by addressing the Calibrator as a listener, transmitting the Select Device Clear which performs a RESET function,

```
clr 711
```

A RESET message leaves all registers in the default power up state (see paragraph 7.4)

Next it is desirable to know that the Model 710 has responded and at the least is sitting in the safe Standby condition. This is accomplished by a Serial Poll and determining if the Deactivate bit of the Poll byte is asserted. The following is typical,

```
0: clr 711
1: wait 1500 (see note)
2: rds(711)>P
3: if bit(2,P);gto 5
4: gto 2
5: NEXT STEP
```

In this routine a 1500 millisecond wait is encountered to allow the establishment of the RESET state. This wait can be left out or made longer as the case requires. See note below. These routines are only examples, many alternates can be derived.

NOTE: It takes the uP about 1 to 1.5 seconds to establish the RESET conditions during which time the interface is not available for communication.

A further elaboration on this routine would be to add an abort routine in the event the device does not reach a deactivated state in a reasonable period of time followed by an operator alarm etc.

7.3.2 Establishing an Active Defined Condition

With the Model 710 in the Standby state an instruction is issued to program the Calibrator for 10 Volts, +dc and 1% deviation range. This would be accomplished by the following program step:

```
wrt711,"FOR3MOD2S:T0U0V0W0Y0H0Z0"
```

As before the syntax wrt 711 addresses the 710 as a Listener and the code within quotes is the instruction word as defined in Table 7-1.

7.3.3 Enabling Operate

To cause the Model 710 to output the preset conditions an instruction is given to assert the Operate state

```
wrt 711,"E"
```

It is usually desirable to include either the set up word or the Operate and Standby command in separate sub routines. A sub routine for Operate could look like:

```
0: wrt 711,"E"
1: wait 200
2: rds(711)>P
3: ifbit(0,P);gto 5
4: gto 2
5: ret
```

This routine continues until the status byte reflects the deactivated

bit has been negated (the compliment of EAP), after which it returns to main program execution. Again, an abort routine could have been added to provide an operator's alarm if the Operate state did not occur.

7.3.4 Reading the ERROR Message

The ERROR message may be read after the Record button has been momentarily depressed. The operator is continuously requested to "PRESS RECORD" until performed. When performed, the EOK bit of the status byte is asserted. The error message is available only if the EOK bit is asserted. If the error message is read without the EOK bit asserted, the transfer of garbage or bus hangup will occur. To avoid this occurring, execute a routine which continuously interrogates the EOK bit until it becomes asserted and then and only then reads the error information.

```
0: dsp"Press Record Button"  
1: rds(711)>P  
2: if bit(1,P);gto 4  
3: gto 1  
4: dsp;red 711, A  
5: NEXT STEP
```

In this routine the statement "Press Record Button" remains on the display until accomplished. When the button is depressed the EOK bit of the status byte is asserted, and when recognized the error is read and the program continues and the display is cleared.

7.3.5 Ending a Test Routine

In the interest of safety the Calibrator should be returned to a well defined, safe state after the task programmed for has been completed. This can most easily be done by issuing the Select Device Clear message from the controller. It may also be wise to check the status byte and confirm that the Standby state was achieved.

7.3.6 General and Precautions

In general it is always good practice to interrogate the busy status bit of the status byte before or immediately after sending data to assure that the Model 710 received the correct information and is not operating on old data. If, in the case of incorrect programming, the input data rate is faster than the Calibrator can allow, at the time that the 60 character input buffer becomes full a device clear routine is automatically established and all data is cleared and Standby is asserted. This could happen if data is continuously sent to the Calibrator when the uP is performing a previously requested task and is not available for handling new data. In the busy mode of operation the uP is not available for other duties.

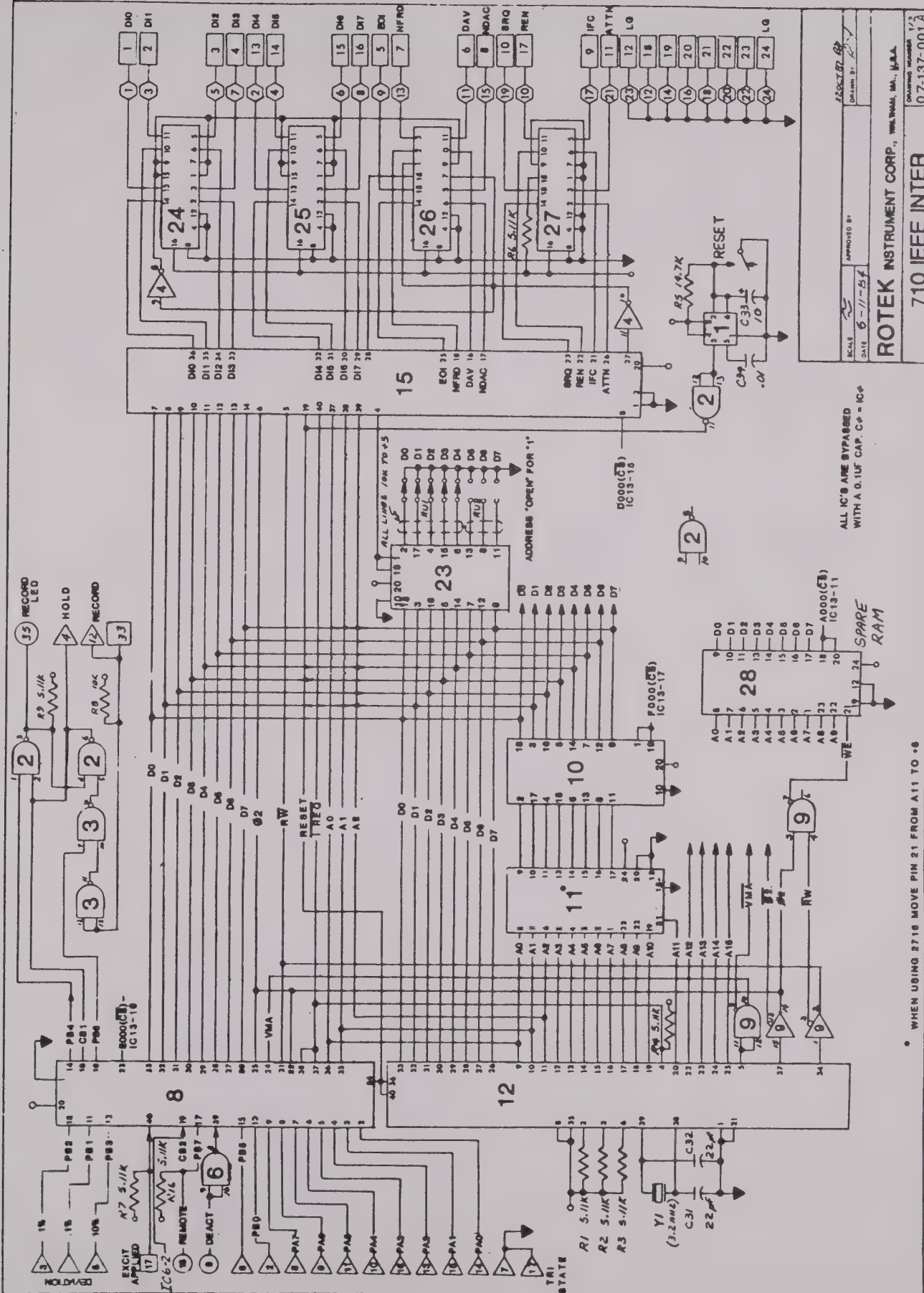
No attempt is made here to examine the diverse intricacies of programming since it is far beyond the scope of this manual. For detailed information on the operation and syntax of the controller through the 488 bus the reader is referred to the instruction manual

for the controller being used. Rotek offers tutorial software to prepare test routines for instruments from specification sheets for the instrument. (710 U.S.I.T./P and 710 U.S.I.T./A). For details please consult the factory.

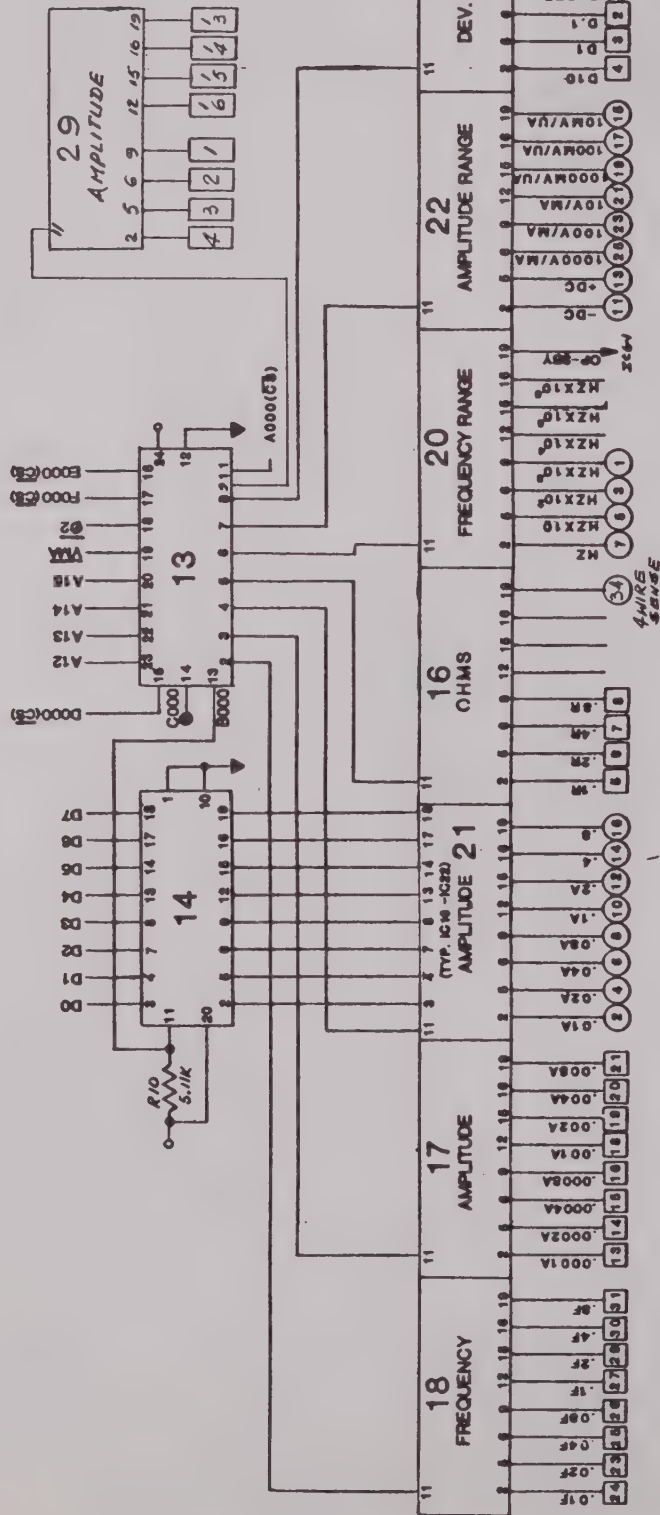
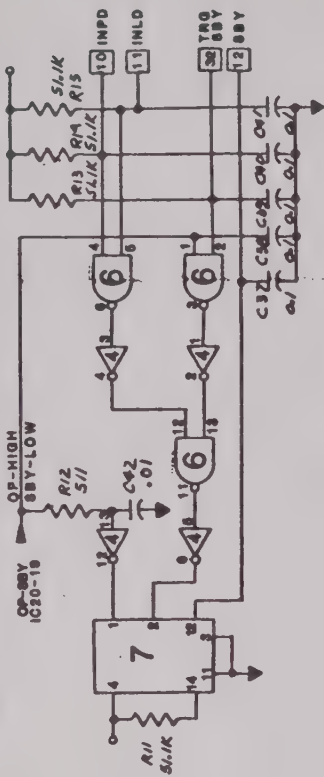
7.4 Default Conditions

Upon power up or after a Select Device Clear the interface output registers within the 710 are set to the following default conditions and will remain stable until changed.

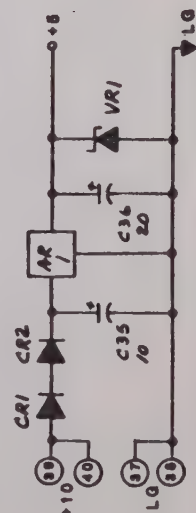
Field	Default
F	Ohms
R	0
M	0
D	OFF
S	0
T	0
U	0
V	0
W	0
Y	0
H	0
Z	0
Operate/Standby	Standby



WHEN USING 2710 MOVE PIN 21 FROM A11 TO +6

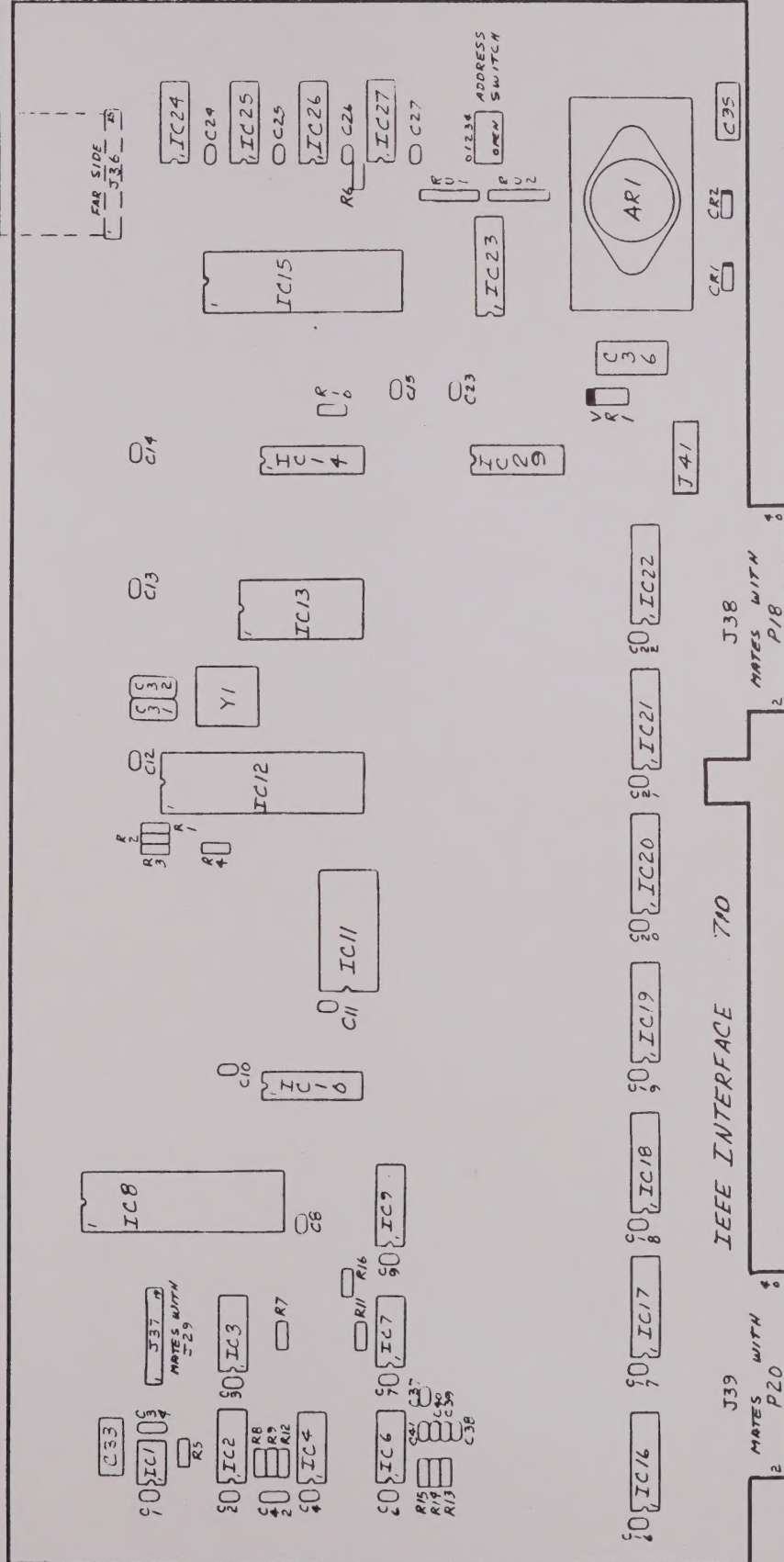


- ☐ J36 TO IEEE INTERFACE
- ☐ J37 TO P29 DECODER 06 200 001
- ☐ J38 TO P18 MULTIPLEXER 06 111 001
- ☐ J39 TO P20 MULTIPLEXER 06 111 001
- ☐ J41 TO J40 AC CON/REF 06117001



22 OCT 87		REV	
SCALE		APPROVED BY	
DATE 6-11-84		DESIGNED BY	
ROTEK INSTRUMENT CORP.			
710 IEEE INTER		07 137 001A	

IEEE BUS
REAR
PANEL
CONNECTOR



DATE 6-19-84	DESIGNED BY H. H.
ROTEK INSTRUMENT CORP.	
710 IEEE INTERFACE CT-137-000	

